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Journal of the

AMERICAN STATISTICAL ASSOCIATION

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The American Statistical Association is a scientific and educational organization. Its membership is not confined to professional statisticians but includes economists, business executives, research directors, government officials, university professors, and other persons who are seriously interested in the application of statistical methods to practical problems, in the development of more useful methods, and in the improvement of basic statistical data. Engineers, mathematicians, biologists, actuaries, sociologists, psychologists, and representatives of many other professions are included in the membership of the Association. Information about the Association and membership application forms may be secured from the Secretary, R. L. Funkhouser, American University, Washington, D. C.

The 104th Annual Meeting of the American Statistical Association will be held in Cleveland, Ohio, December 28 to 30, 1942. With a few exceptions the sessions are open to the public.

Chapters of the Association have been organized in important cities in the United States. Information concerning the meetings of these chapters may be secured from the District Representatives listed on another page.

The Editors welcome the submission of articles and notes for possible publication in the JOURNAL. Manuscripts should be sent to the Editor, Journal of the American Statistical Association, American University, Washington, D. C. Books for review should be sent to the Review Editor, Glenn F. McLaughlin, American University, Washington, D. C. Authors who wish suggestions about the preparation of manuscripts and charts or information about editorial policies should address their inquiries to the Editor.

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GOVERNMENT AND THE STATISTICIAN*

By Winfield W. Riefler

In 1917 the statistician invaded Washington. He came to man the war agencies, to build up a service of economic reconnaissance for the more effective mobilization of our resources. He found there little data with which to work and few colleagues with whom to consult. Those colleagues that he found were centered largely in the Census Bureau. Though small in number, they were an able group, pioneers in the long endeavor to construct a more exact description of the society in which we live. Frequently the volunteer who came to Washington in 1917 did not know that he was a statistician and did not become aware of that fact for some time afterward. He was, usually, an economist who had had little opportunity to familiarize himself with factual data in quantitative form. He had, however, a great faith in facts and soon acquired an enthusiasm for the questionnaire. When he departed, he had been exposed to a new range of problems and to a factual technique for dealing with those problems. He left behind him a mass of unassimilated data for other statisticians to digest.

During the past eighteen months, a second army of statisticians has invaded Washington. They, too, have come to man the emergency agencies, to provide the fact finding that is the basis for industrial mobilization in a modern war. They did not come to a statistical wilderness, however, nor have they lacked colleagues in number to welcome them. They arrived at a humming center of statistical work, rich in data, and widely staffed by specialized experts. Those who arrived, moreover, have differed from the earlier invaders. They have not been "rookies," but skilled workers already versed in statistical techniques.

The contrast in these two situations, separated by less than a generation, portrays a development of profound significance to statisticians, particularly economic statisticians. In the interval between the two wars, statistics have "come of age" and the statistician, as a species, has multiplied. The pattern of this phenomenon has not been peculiar

* Presidential address presented at the 103rd Annual Meeting of the American Statistical Association, New York, December 29, 1941.

to this country. The same development can be traced, subject to local variations, over wide areas of the globe. In a very real sense, nevertheless, it *has* been an American phenomenon. In the area of ecenomic statistics, faith in the statistical approach, energy in the compilation of new data, and reliance on statistical findings were early in making their appearance in this country. Throughout the past twenty-four years, this faith, energy and reliance have tended progressively to spread outside of our borders. They have been contagious and have quickened the adoption of comparable procedures abroad. One may say that they have constituted a cultural export. Just as faith in the new industrial techniques, and knowledge of the machine on which they were based, constituted a leading cultural export of Great Britain during the nineteenth century, we have exported an enthusiasm for the statistical approach in the twentieth. As a cultural export, this development may be ranked with our earlier missionary activities in Africa and the Far East, and with the picture of American life spread throughout the world by the movies during more recent years.

GOVERNMENT AS A FACTOR IN THE EXPANSION OF STATISTICAL ACTIVITY

It is no accident that the statistician first came to Washington in numbers in 1917, for it was then that government in this country first embarked on its course of intimate contact with, and direct intervention in, our economic life, a course which has been pursued continuously during the interval. Fundamentally, the concurrent expansion of activity in the field of economic statistics has reflected this development. Throughout the period government has been the great manufacturer of statistics. This does not imply that statistical activity has been confined to the public services nor that the statistician had no contribution to make to our understanding of economic developments prior to 1917. His contribution might have been great during those earlier years had he had the opportunity. However, in that era of economic liberalism—of free economic activity with as little interference as possible by the state—his contributions were necessarily limited because there was no single organization sufficiently powerful, or in possession of sufficient funds, to finance the acquisition and compilation of data on which statistical work depends.

All this was changed in 1917. The first World War was the occasion for the acceptance on the part of the government of widespread responsibility for participation in the conduct of our internal economic affairs. This participation changed its form, but did not end, at the close of the war. It has continued, in fact, and grown during the inter-

vening years. It has had mixed origins, reflecting, on the one hand, the voluntary initiation of measures directed toward the improvement of social conditions, and, on the other, a response to new problems imposed by the growing tension of the times. In the post-war period the government was forced to assume a degree of responsibility for economic readjustment and reconstruction. After the great collapse, it was government that was called upon to create some sort of economic order out of the chaos of 1932. In the succeeding era of world-wide economic disintegration and increasingly aggressive economic nationalism, agencies of economic intervention have tended to multiply, at first in support of exposed elements in the economy, and more recently to mobilize the economy for total war.

Taking the twenty-four years as a whole, this great growth in governmental functions bulks larger than any other single factor in the expansion of statistical activities. The statistician has found in government both sources of new data and an audience intensely interested in such findings as he was able to make. Government has certainly not been the *sole* source of new statistical data during this period, nor has it enjoyed any monopoly in the application of statistical analyses to the elucidation and understanding of current problems. In a very important degree, in fact, pioneering in the development of economic, financial and social statistics, in statistical techniques, and in their application has continued to originate in non-public agencies. Witness, for example, the recent innovation of the so-called public opinion polls. It remains true nevertheless, that in almost all phases of their activities, statisticians have been heavily dependent on government support. Public funds have financed in great part the collection of statistical data; public bodies predominantly have fostered the development of new statistical series, and public agencies have relied more heavily than others on the use of statistical guides for the development of administrative policies.

There are several reasons why this should be so. The cost of collecting mass statistics is frequently prohibitive. It is only a public agency supported by public funds that is in a position to decide to collect such basic data as are found, for example, in the Census Bureau. Furthermore, much of the statistical data on which we have come to rely, originated not as a result of a conscious decision to undertake their compilation, but rather as a necessary by-product of public administration. Our import and export statistics are a case in point, constituting essentially a by-product of customs administration. Thirdly, the activities of public administrative agencies are usually comprehensive in scope and their records are usually open to public inspection. In

consequence, statisticians have found in these records rich sources of statistical data. Public agencies, finally, have tended to place administrative reliance on statistical findings in the development of public policies because the field of their responsibility is broad. They have found that they could not afford to rely on opinion or impression when more objective bases for decision were available. This has meant, in the turmoil of the last quarter century during which government has tended to intervene ever more actively in economic life, a rapid stimulus to the availability, compilation and use of statistical data, especially data of economic significance.

Although the trend toward public participation in economic life appeared later in this country than in most of the other major countries, and rarely in so extreme a form, it had as a by-product, almost from the first, a parallel development of statistical activity. Because of our huge size and of the diversity of our internal conditions, there was earlier appreciation here of the need on the part of public authorities for objective factual data to describe conditions covering the country as a whole. They could not afford to place the same degree of reliance on experience, intuition, and impression as the authorities of smaller or more homogeneous states. Because of our more decentralized form of government, with powers and activities widely distributed between the Federal government and the states, public records have always tended to be more voluminous here than abroad. Our statisticians enjoyed, in consequence, earlier access to a wide variety of existing data capable of throwing at least some light on new problems as they emerged. Underlying both of these developments has been the American temperament, i.e., the willingness of the American to furnish information. In this country we have not experienced the same resistance to the gathering of statistical data, particularly data voluntarily supplied, as in many countries abroad.

Given these favorable conditions and the opportunity to demonstrate his technique on a large scale, the American statistician "came through." He was a success. With scattered data, often fragmentary, at his disposal, he was able to block out the order of magnitude of important elements in our economy about which we had hitherto been ignorant. With more adequate data he was able, frequently, to furnish fairly precise guides to decision. In a world characterized by increasing uncertainty, he was able constantly to whittle away at the area of the unknown.

These activities varied widely both with respect to the agencies by which they were sponsored and the diverse sources of data which were subjected to exploitation. They fall, nevertheless, into a general chrono-

logical pattern, that reflects in its shifts of emphasis the changing focus of government with respect to economic problems. Taking the period as a whole, there were three such major shifts—in 1920, in 1933, and in 1940—each corresponding to concurrent changes in the orientation of public policy. In large part these changes were initiated by the statistician, and thus represented a flexible response on his part to changing social needs. To a certain extent they were involuntary, however, forced by conditions over which he had little control. The statistician is a technician. He must have data, the collection and compilation of which are costly. Under these circumstances his major fields of operation are bound to reflect to a considerable extent areas of interest for which support of his activities can be obtained.

It is not surprising that, beginning in 1920, efforts were concentrated on the collection of banking data and on general economic data suitable for the construction of economic time series, nor that the research divisions of our monetary agencies were prominent in this role. This was the period in which we still conceived of our economy—domestic as well as international—as an integrated whole, maintained in equilibrium through a flexible system of prices. We thought of the business cycle as the great menace to the health of that whole. Our social thinking, consequently, was oriented toward the development of public policies, chiefly monetary policies, adapted to mitigate or eliminate the business cycle. It was assumed that these policies would operate over the whole economy and that, so long as that economy was maintained in stable equilibrium, its constituent parts would be secure. For the formulation of public policies directed toward these purposes, banking data were essential, together with economic time series, and the general purpose index numbers, based frequently on fragmentary but symptomatic data, which were constructed in this period, were in accord with this diagnosis. Though limited in coverage and subject to wide margins of error, they were useful in the interpretation of general trends in the economy, particularly those that were cyclical in character.

The principal exception to this generalization is to be found in the fields of agricultural statistics and coal mining statistics. All during the 1920's it was apparent that there was a malaise in agriculture and coal that was more than cyclical. In these two fields, consequently, statisticians pushed their work far beyond the construction of index numbers. They developed, in addition, data on a comprehensive basis capable of aggregation into relevant categories adapted for the detailed study of these specific segments of our economy.

Beginning in 1933 this latter type of statistical activity tended to generalize. In the long descent from the collapse of 1929 to the depths

of 1932, attention shifted from preoccupation with the state of the economy as a whole to concern over certain of its constituent parts. Public policy was directed more actively toward specific support for those parts on the assumption that such rehabilitation was a necessary prerequisite to the restoration of health to the whole. Statistically this shift in emphasis was reflected in such activities, to enumerate only a few, as the development of relief statistics, statistics of employment and unemployment by industrial categories, urban mortgage statistics, the segregation of industrial statistics of all kinds into durable and nondurable categories, and in a widespread attempt to describe statistically the forces that play on the construction industry.

A third shift of emphasis has characterized the past eighteen months, adapted to the mobilization of our resources for war. For this purpose, highly individualized data, frequently plant by plant, are needed, in addition to time series and to statistics descriptive of the economy by major economic segments. The Bureau of Labor Statistics index number of wholesale prices, for example, despite all its recent refinement, does not furnish sufficient data for the establishment of price ceilings. Nor are our industrial data, in all their elaboration, adequate for the purposes of the OPM.

While government has played a major role during the past generation both in providing support for and promoting the use of statistical data, particularly economic data, statistical activity has in no sense been restricted to public bodies, nor has it been confined to the area of economic phenomena. The period has been characterized by intense activity throughout the various fields where the use of statistics as a tool of analysis is capable of making a contribution. Within the field of economic data, much of the pioneering work, as, for example, in the field of income statistics, was initiated outside the government. Public agencies have not, in general, been prominent in the development and refinement of statistical methodology, nor in the elaboration of techniques of statistical analysis. They have made contributions in this area, but in general they have borrowed their methods and adapted their techniques from academic sources. Private business and finance also have participated in the general development of statistical activities, both in the interpretation of existing series and in the compilation of new data, as, for example, in the case of statistics gathered by trade associations. Financial institutions offered a major outlet for statisticians during the twenties. Market research has provided comparable opportunities in more recent years.

Public support, however, has remained at the core of the movement. Each new activity has increased the demand for statisticians in the

public service. Each new adoption of statistical techniques outside of the government has led to augmented demands on public agencies, such as the Census Bureau, for additional information. These demands have reacted in turn on universities which have been called upon to develop more refined methods of analysis and to augment their teaching programs in order to supply an adequate number of skilled technicians. In a sense, therefore, the army of statisticians that came to join that small band of pioneers already functioning in Washington, was never truly evacuated. The current heavy influx to man the defense agencies constitutes merely the latest phase of a phenomenon that has continued with few interludes throughout the intervening generation.

STATISTICAL CONTRIBUTIONS TO ECONOMICS

In view of the enormous resources thus placed at the disposal of the economic statistician during and since the first World War, it may properly be asked: What has the statistician done with these opportunities, for economics, for the social sciences? What progress has been made in the endeavor to describe quantitatively the economic environment in which we function? To what extent have we been successful in establishing more precise quantitative relationships between functionally related elements of this environment? What has been done with these findings? To what extent have they improved our wisdom as well as our knowledge? Is control of the business cycle more nearly within our grasp?

So far as success in describing the economy in which we function is concerned, the answer is, I think, decisive. The statistician has seized the opportunity to advance immeasurably our knowledge of the structure of our economy. So great is the extent of this advance, in fact, that no one person, no matter how expert, is any longer in a position to appraise it. The economist of 1917 could, if he chose to specialize, be reasonably conversant with the sources of all of the major statistics that were available to describe our economy. He could also retain in his memory a great bulk of the more significant of those facts. Today, it is doubtful whether the entire staff of any one of our most highly organized and competently equipped agencies for statistical research is in a comparable position. In spite of all the work that has been done to digest and to assemble into major categories the wealth of statistical materials now available and to reduce their movements to index numbers, the research agency of today must specialize in one or more fields of data. It relies upon intimate contact with specialists in other agencies to make good its deficiencies.

In a very important degree, many of the statistical aids which we

now accept as common knowledge, were completely lacking only a short time ago. Take, for example, statistics of national income. The monthly figures, on which so much current reasoning is based, are a product only of the last few years. Even continuous annual estimates did not become available until the twenties. Except for imports and exports of gold, we knew nothing of the current movement of international financial transactions until very recently, while the whole development of systematic data with respect to the balance of payments goes back also only to the early twenties. Before then, statistics of physical imports and exports comprised the bulk of our knowledge in that field. The statistician in 1917 did have a wholesale price index to follow, but an index much less revealing than that which we now scrutinize to measure the progress of war inflation. It is difficult to comprehend today, but nevertheless true, that we had no index of physical production whatever until the early 1920's. There were also little or no data on retail trade, on employment, or on wages. It is amusing, today, to re-read the most carefully compiled economic summaries of that earlier period from the point of view of the adequacy of the data that were used and their relevance to the inferences which they were cited to support. Bank clearings were considered a most important index of business activity, while railroad car loadings were studied for information on the state of retail trade.

In addition to these advances in sheer description of our economic environment, considerable progress has also been achieved in the establishment of functional relationships between diverse elements in the economy. The recent work in the important field of consumption statistics, for example, has provided a working basis for estimating the consumption habits of different classes in the community by income groups. We know in considerable detail the relative importance of different production groups. We now have records painstakingly traced back, breaking down our total economic effort into service production and commodity production, with further breakdowns of commodity production into nondurable consumers' goods, durable consumers' goods and producers' goods. We are able to assess the importance of maintenance activities in our economy, to measure the total of gross capital formation, and to establish the fact that a very large component in that total consists of replacement of existing facilities.

The relationships established by these basic statistical contributions have been highly suggestive. They have certainly laid the ground work for the new theories of employment, consumption, savings, and investment with which the economist is now working. There can be no question that they have added very greatly to our knowledge of the

functioning of our economy and of the mechanism of the business cycle. Opinion is less unanimous as to whether they have increased our wisdom with respect to its control.

OFFSETTING FACTORS

There is a different kind of question which may also be asked with respect to the influence exerted on the social sciences by the statistician and by the statistical approach. What has the statistician done *to* the social sciences? Has he contributed directly or indirectly, advertently or inadvertently to the social, economic and political disintegration that has culminated in this second World War?

The statistician, almost by definition, because of the material with which he works, cannot help but emphasize the immediate, the concrete, the specific, the tangible. Has he, by this very fact, in this period in which he has been successful, tended to direct attention from considerations and developments that have been long-run and intangible? Have the quantitative relations which he has demonstrated between different elements in the economy been so compelling in their power to attract attention that they have been over-emphasized as compared with other relationships, just as true and valid, but non-demonstrable statistically? In other words, has he made the economist more akin to an engineer and less responsible as a social philosopher?

The statistician must work with data, most of which have been national in their coverage. Predominantly he has developed these data in a form that would be useful to public agencies, the specific responsibilities of which were national. Has he, by this very fact, over-emphasized the national economy at the expense of the international organic whole of which it is but a part? Just how relevant are the concepts of *national* income, *national* production, in a world dedicated to non-totalitarian ideals? Have they not, in the absence of comparable world data of which they are essentially but a segment, tended to be over-emphasized, to become the central focus of analysis? Has the reiterated use of these statistical measures done something to the concepts behind them? Has it tended to make our economic thinking stop at the political border? In short, have we exported a flavor of our isolationism along with our enthusiasm for statistics?

There is, of course, no ultimate answer, pro or con, to probing questions such as these. We can only note them and resolve to overcome the faults implied in them as opportunity permits. With respect to one of them at least, however, we must plead guilty. There is no question but that we have over-concentrated on national data, that we tended to become complacent once our *internal* national economy had

been described. When one considers, on the one hand, the enormous efforts that have been devoted to the development of economic data during the past generation, and, on the other, the basic inter-relationships that knit the world's economy into a whole, it is difficult to explain the paucity of our statistical knowledge with respect to that whole. It can be accounted for in part, probably, by the fact that world data covering activities under the jurisdiction of many different political sovereignties are subject to wide gaps, and even when available, are frequently non-comparable in form. In our internal compilations, however, when we faced the same difficulties, we have frequently devised means to surmount them. Chiefly it is to be explained by the factor suggested above, namely, that so many of our research agencies have restricted their work to the development of series that would be useful to the public bodies for which they have worked, whose responsibilities were largely national. It is significant to note in this respect that we are indebted to the Economic and Financial Section of the League of Nations, a research agency responsible to an international body, for an important segment of such economic data as we *do* have on a world basis.

FUTURE LINES OF DEVELOPMENT

Adequate provision to make good this major gap in our information is one of the most important tasks facing the economic statistician today. Valuable as it is, the ground work already developed under the League and other international bodies barely scratches the surface of the problem. The world indexes now available, such as those on production, on international trade, and on stocks of primary materials, need to be broadened. We need economic time series comparable to those we have at home because the business cycle is not an internal phenomenon nor are its ravages confined to any one country. We need industry surveys on a world basis because the malaise which has stricken our basic industries—coal, textiles, cotton, wheat, coffee, and sugar—has in most cases a non-national origin. We need geographic area studies by industrial regions on a trans-national basis because these studies are essential to the rebuilding of our shattered world by the opening of markets and the provision of investment funds. Effort devoted to tasks such as these will pay well in dividends. It has been my privilege recently to go over some preliminary analyses of international trade statistics, integrated by regional geographic areas. I have rarely encountered a situation where a simple analysis, achieved mainly by the regrouping of familiar data, did more to undermine preconcep-

tions in understanding and to clarify intellectual areas that had hitherto been obscure.

The preliminary attack on this wide new field of statistical research is already under way. Under the impact of war, various agencies of the government have found the area of their responsibilities broadened to include activities outside our borders. They are being called upon to make decisions with respect to these activities and find themselves in need of non-national statistical data as a basis for those decisions. Mobilization of our industries for war has revealed deficiencies in our internal supplies that must be supplemented from outside. Economic warfare calls for intimate knowledge of critical elements in the economy of the enemy. Support of friendly powers requires information on which to base decisions with respect to priorities, to sustaining purchases, and to loans. For all of these purposes economic data are required, economic data that consist of more than a summary, nation by nation, of purely national statistics. For many purposes these data must be developed on an integrated basis, international or trans-national in character. These activities may go far before the war is over. It may be that in this war a basis will be laid for international statistical research comparable to the basis laid for national statistical research in 1917.

The trend, so established, will probably not be limited to the war period. If any forecast of the future is possible in this period of obscurity, it is that we have passed the crest of the era of national economic isolation. The post-war world, whatever its specific character, will be forced to recognize the problem of international economic interdependence, and to deal with it. That problem, furthermore, will be dealt with by public bodies in some form, such as international agencies, or joint commissions. We will have, therefore, all of the conditions requisite for the inauguration of successful research, the existence of a problem requiring the quantitative clarification which the statistician is able to provide, the presence of a fair body of data on which to work, the support of public agencies in possession of sufficient resources to prosecute effective inquiry and, finally, a pressing need on the part of those agencies for objective economic data on which to base their decisions. In the development of those data, essential for the preparation of plans and the formulation of policy, the statistician of the future, it is safe to predict, will have a unique opportunity to dedicate his energy to the reconstruction of an integrated world.

THE PROSPECT FOR 1942*

A NEW PRACTICE has been inaugurated of bringing to the membership a composite of the forecasts for the year 1942 of fifteen distinguished economic statisticians in business, government, and research. The results were presented and analyzed by W. Randolph Burgess, vice chairman of the National City Bank of New York and a former president of our Association.

The reporting statisticians agreed in predicting an increase in 1942 in industrial production, the individual forecasts ranging from an increase of one per cent by December 1942, to an increase of 15 per cent. The average estimate was for an increase of 9 per cent from December 1941, to December 1942, compared with an increase of 21 per cent during the year 1941. The estimates also agreed that both wholesale prices and the cost of living would be substantially higher a year from now. In the case of wholesale prices, estimates ranged from an increase of 13 to 29 per cent, with an average at 18 per cent. In the case of the cost of living, the range of estimate was from 6 to 17 per cent, with an average at 10 per cent.

Mr. Burgess said that these statisticians evidently expected the increase in war production to more than offset decreases in industries affected by priorities and shortages of materials. Actual entrance into the war may be expected to stimulate war production both in terms of the size of the program and the energy with which it is pursued.

In judging the effect of the war on prices from the point of view of the economics of the situation, inflationary forces are increased, as the amount of government spending expands. On the other hand, the still more important political factors in inflation are more favorable. The people will be more willing to tax themselves heavily and resist the efforts of pressure groups to raise agricultural prices and wages, and maintain non-defense spending. The political question, however, remains the dominating factor with respect to the country's ability to resist inflationary forces.

In World War I statisticians had to fight for a chance to demonstrate their usefulness. In the present war they are being eagerly sought after. Their responsibilities are correspondingly greater, and their success will depend more upon their power to find out what facts and interpretations of fact are needed by the people who make decisions than by their technical competence in refined statistical methodology.

* Abstract of material presented at the 103rd Annual Meeting of the American Statistical Association, New York, December 30, 1940.

PRICE FIXING OF AGRICULTURAL PRODUCTS*

By Warren C. Waite
University of Minnesota

One of the major control problems of a war is that of restraining or preventing a disastrous rise in prices. At the outset it should be clearly recognized that price fixing in itself will not prevent a price rise unless it can be enforced by drastic means plus, of course, vigorous rationing. The mere fixing of prices does not provide a fundamental solution to the problem of rising prices. At best it is only an aid.

The fundamental cause of a general rise in prices is that the purchasing power in the hands of buyers rises relative to the quantities of goods available for purchase. The real solution to this problem is either to reduce the purchasing power of the buyers or to increase the volume of production of goods available for purchase. The latter, with the demands arising from a war effort, is clearly impossible in many lines of production. Agriculture, perhaps, constitutes a notable exception. The reduction of purchasing power is possible, and efforts in this direction may be expected to be carried out, but it is difficult in a complex economy to recapture all increases or to drive very deeply without creating grave injustices or hardships among classes in the community. Insofar as this balancing of goods and purchasing power is accomplished, the task of price fixing is made easier, and complete success in this respect would eliminate the need for the major portion of it. Even an over-all ceiling such as has been proposed by Mr. Baruch and others cannot prevent price rises if purchasing power is unrestrained or not taxed away. If you fix prices without changing the quantities of goods or purchasing power, then people will buy up everything at the established prices and have purchasing power left over. These free funds will surely lead to price rises.

Public opinion will do a great deal in helping to police a price-fixing scheme. In fact, we must depend pretty largely upon it to insure the success of any plan in the United States. There are, however, the difficulties that people don't know what prices ought to be, and there may still be among us those who are more interested in bettering their own situation than they are in the general welfare. Certain prices are not and cannot be very well known, for example, the price of agricultural land, of second-hand goods, or the services of domestic workers. These and others may easily be bid up. Lack of success here might easily

* A paper presented at the 103rd Annual Meeting of the American Statistical Association, New York, December 27, 1941.
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jeopardize the whole scheme. Assuming, however, a moderately successful control over purchasing power, it would appear that selective controls might be employed in the fixing of prices with considerable effectiveness. Among these selected prices will be certain agricultural products.

Any plan of price fixing should meet two general requirements. It must first be economically sound, that is there must be some real economic objective that can be brought about by the price fixing and that will be secured by it. Secondly, it must be administratively feasible. No plan, however desirable it may be from an economic viewpoint, is worth anything unless it can be administered. The difficulties of administration will be lessened to the extent to which the market can be made to function in its usual capacity during the period of price fixing. This suggests that whenever there is a choice of means for accomplishing a desired result, the one that provides a larger degree of automatic regulation through the agencies now available should be employed. The price administrator should conceive of his function as that of assisting the market to operate in a way beneficial to the common purpose, rather than one of supplanting or replacing the normal market.

In order to fix prices on agricultural products it is necessary to have in view the underlying economic purposes of such price fixing. Two important but partly contradictory purposes stand out at once. The first is to aid in the allocation of the costs of the war among the various groups in the community and in the case of agricultural price fixing the allocation between agriculture and the other groups. The second is to guide agricultural production during the war with a view of securing adequate supplies and adjusting agriculture to a position to be able to withstand the shock of returning to a peace-time economy. Preventing agricultural prices from rising too high will aid in restraining a general rise in all prices in several ways. Lower agricultural prices will lessen the cost of purchases of many goods bought by the Government. It will also keep the cost of food to workers lower, and this should lessen the pressure from the laboring classes for wage increases. Food is a large part of the worker's budget and a part in which he seems to be especially aware of price changes. Moreover, many persons will fail to secure appreciably higher incomes during the coming period, and for these persons a rise in food costs might create considerable hardships. Keeping agricultural prices down would also dampen the rise in agricultural incomes and lessen the increase in purchasing power in the hands of the farmer. This would curtail his ability to buy other

goods and in consequence his contribution toward inflation. There is thus in setting agricultural prices an income allocation between agriculture and the remainder of the community. This includes the tacit assumption that income or purchasing power in other hands is more diffused, less influential in producing price rises, or more subject to control than when in the hands of the farmers.

Price fixing also offers an opportunity to adjust agriculture toward an allocation of resources deemed more desirable and to accomplish this without the high cost to the remainder of society that might be involved if all prices were allowed to remain free to rise. Allocation of resources among productive enterprises in agriculture depends a great deal upon the relative prices of products. It is only the total volume of resources utilized by agriculture that depends in large part upon the level of prices. Total agricultural resources are not going to change very greatly either under high or low levels of agricultural prices, but considerable shifts among enterprises will take place with changes in the relative prices of products. Expansion of total agriculture production is likely to be nearly as great with a fair increase in income as it would be with an enormous increase in income.

To say that we want to adjust agriculture is not, however, to say that we are entirely certain just what that adjustment should be. The immediate problem is fairly clear, but the long-run problem is extremely uncertain. Immediately we need a schedule of requirements for the war effort together with the requirements for emergency stocks. There should naturally be a schedule in terms of absolute minimums and another of desirable quantities. We also need to recognize that it is more desirable to err on the side of too much rather than too little. We can always use up too much even if the process is painful for many, but deficits might be fatal.

This is not, however, to say that we should close our eyes to the future following the war even if our present view of this future is vague. It is obvious that we must currently produce what is essential to the prosecution of the war, but we must also keep in view the long-run as far as we are able. It is essential that we do this because we cannot avoid the difficulties of the future by the simple assumption that any increase in production induced now will be demanded by ourselves and our neighbors following the war. There may be needs from a nutritional viewpoint in our own population and from a humanitarian viewpoint for Europe, but whether a people in the crisis of a great adjustment to a peace economy and already burdened by the costs of a contribution to a war can freely give or will be willing to is an un-

decided question. The war, rather than solving our agricultural problem, will serve only to intensify it at the close, and present plans must keep an eye upon the possibilities of this future.

Any price fixed for agricultural products must face, perhaps in the law providing for price fixing and certainly among the farmers themselves, the handicap of comparison with "parity" prices. The idea or concept of parity is one which has come to be associated with the idea of right or justice in the minds of many agricultural leaders and the farmers themselves. Any ceiling set at parity levels would be likely to be accepted at once by the agricultural group as "fair," while it is conceivable that any price set below parity would be felt unjust if not actually objected to.

The idea of parity found its first legislative expression nearly a decade ago in the Agricultural Adjustment Act of 1933. In this Act it was declared to be the policy of Congress to reestablish prices to farmers at a level that would give agricultural commodities a purchasing power with respect to articles that farmers buy equivalent to the purchasing power of agricultural commodities in a base period. Briefly the essential calculation is to multiply the average price of the commodity in the base period, usually August 1909 to July 1914, by the index of the cost of things bought by the farmer, with the base of this latter index also from 1910 to 1914. This underlying idea has been expanded and developed in later agricultural legislation in various ways and has come to saturate agricultural proposals of many kinds.

Parity price and parity income have become an important ethical concept of what farmers ought to have in view of a situation in an earlier period. Price fixing in a war period should be unhampered by any legislative requirement to provide some historical relationship. The price administrators should be left free to operate as current conditions demand. The difficulty with parity prices as a criterion for ceilings in a war emergency is that they may be and probably are too high to provide the results selected as desirable or demanded in the fixing of many prices in such a period. In retrospect, the period 1910 to 1914 appears especially favorable for agricultural prices in relation to non-agricultural prices. To continue such a relationship in peacetimes is to invite the accumulation of forces tending to destroy this very relationship, and to force a set of price relationships of twenty-five years earlier on a price administrator is to handicap severely, if not to defeat completely, his efforts. Cost relationships among the commodities have changed greatly, and to provide parity prices for some commodities would perhaps stimulate their production greatly. To offset these shifts it would be necessary to establish price differences between prices

to enable the ceilings to exercise a directive function and a requirement of parity for the lowest prices in such a system might easily lift the entire level so high as to lose all possible inflationary control. If parity prices as minimum requirements in themselves promise to be faulty, then all that can be said about the proposal to provide a 110 per cent of parity minimum for any ceiling established is to make nearly certain the failure of agricultural price controls.

Assuming that the price administrator has been left with a fairly free hand, then in view of the purposes of agricultural price control which we have indicated the two principal problems for the administrator appear. The first is to establish a general level for agricultural prices relative to the remaining prices in the system, and the second is to establish the desired set of interrelations among the agricultural prices themselves. The criterion for the general level of agricultural prices is one of the amount of purchasing power which it is desirable to have in the hands of the farmers. While this cannot be determined precisely, two over-all measures will be useful. The first is the purchasing power in the hands of the agricultural group as determined by currently available data. This purchasing power should not be allowed to expand markedly nor should prices be set so low as to decrease it greatly. Here the administrator should probably tend to err on the upper side, as he probably will, because not to may easily mean political suicide. The second criterion is the proportion of consumers' income being expended on foodstuffs. This sets an upper limit to be watched. The proportion of the expendible consumer purchasing power going for food should not be shrunk. Indeed it might properly be permitted to increase on the grounds that the great decreases in consumption must occur in other goods than in food. This would be an aid to the control of these other commodities. There are, however, many variations in the increase of purchasing power among the consumers and these increases must be brought under control primarily by other methods. In addition to these, of course, the relationship of agricultural income to consumer food expenditures is to be observed as an indication of what processors and retailers are doing. On the grounds of production response as a whole it does not appear probable that prices are likely to be too low as judged by these criteria. Patriotic motives will lead to nearly as large an increase in production as would occur if prices were left to skyrocket.

Once the general level of prices has been decided upon, there follows the problem of adjusting or fixing the individual prices about this level. The purpose here is primarily that of the adjustment of the production of the various agricultural commodities. Much of this could

be accomplished by simply making known to farmers the deficits, but this process can undoubtedly be facilitated by price manipulations. The criterion here is the rates at which these commodities are forthcoming relative to their requirements as determined by the overhead planning agency. Fortunately the data underlying all these decisions are pretty well at hand, and there is a vast quantity of administrative skill and judgment in the Department of Agriculture and among the farmers as a result of their own discussions of recent years.

The decision of the level at which the price shall be set having been made, the next problem becomes one of where and at what stage of the market it should be established, and what shall be done with respect to prices at other stages in the market or within the market area. One might establish only retail prices and allow farm prices to flow back from them. The retail price structure is, however, extremely complex and would probably be upset by even the simplest structure that could be devised. Another way would be to establish farm prices and allow the retail prices to be built up from them. Areal price structures for agricultural prices are also complex and offer difficulties of somewhat similar nature. The remaining major possibility is to set prices in a few of the major central markets and to have farm and retail prices flow from them. Central market wholesale prices have always been the great gauge by which agricultural products have moved and exchanged, and matters could be simplified if price fixing could proceed through them.

As long as the prices which are set in the central markets are reasonably well in line with prices that would have been established under ordinary competitive conditions in those markets, this procedure should work fairly well. If, however, prices are set that do vary widely with the price that would have prevailed without regulation, then marked changes may be brought about in the way and rates at which products are marketed, and this might force price fixing to be extended beyond the central market.

Dealing only with central market prices would permit at least for the time being retail prices to go unregulated. No retail regulation would be necessitated before retail prices began to rise relative to farm prices. Here again we would do well to fall back on the general principle of permitting the market to police itself as far as possible automatically. It seems probable that the consumers themselves would be able to exert a great corrective influence if only they are provided with proper information. Neglecting for the time being the perhaps crucial question of the ability of the consumer to judge quality in many products, much certainly can be accomplished by the provision of proper price

information. This would begin, of course, with lists of reasonable prices. A more important requirement would be that the merchant display the price which he paid for the goods sold along with his retail price to the consumer. If we accept the proposition that the consumer is entitled to know the truth about the goods which he buys, then the question is only whether the retailer's margin is his legitimate trade secret. Given this information, we could expect the consumer to do a pretty good job of protecting himself. A little shopping around would disclose those with suspicious margins or unusual costs of buying, and these could be subsequently called upon to verify their statements. Such a procedure would also work toward an improvement in marketing by giving an advantage to the more efficient and lower cost retailers.

The situation with respect to setting prices on the various grades of the commodity is essentially similar to that of areal designation of prices. As long as the level that is established for the dominant central market grade or grades is fairly close to the level that would otherwise have prevailed, the grade differentials should work out reasonably well. It is only when price rises have been greatly curtailed that grade differentials become necessary.

It is when we come to the field of production and the holding of commodities that price fixing may be expected to result in the greatest changes from the usual procedures of the market. To a large extent many of these changes will be unforseeable and unusual in their character. The decisions with respect to agricultural production are made by a multitude of farmers upon their individual farms. At certain times of the year, or perhaps in some cases less frequently, the farmer must canvass his resources and the prospects for returns in the future with a view of the best utilization of those resources. In this allocation prospective prices, naturally, occupy an important place in calculations under ordinary circumstances. With price uncertain there will be a wide variety of estimates as to the probable price and a variety of reactions to the same estimate on the part of different producers depending upon their faith in their own judgment and the inclination to take risks in the hopes of larger returns. With prices established, many of these uncertainties vanish and the calculations of what will be profitable differ materially. We will probably be wrong if we base our assumption of responses on historical relationships and do not modify them by some sort of an adjustment for this difference. This presupposes that prices are announced in advance, and such an announcement would be essential if prices are to exercise a directive force over agricultural production.

There are additional difficulties in establishing the prices of agricul-

tural products beyond determining the level for them in a particular period. These arise because of the seasonal character of production and the variation in the volume of production in various years. Many agricultural products have wide seasonal movements in their prices. These are induced by the heavy production at certain periods of the year and the necessity of storage to level out the rate of movement into consumption and for the processing of the product. It is evident that the price fixed will need to include a seasonal movement. This seasonal must be reasonably correct, otherwise great peculiarities in the rate of marketing may take place. If a single price is established for the year, then there will be no incentive to hold and everything will tend to go to the market at once unless some sort of a quota system is established for sales. Some system of monthly quotas for sellers could of course be devised, but such an administrative task would be an unwarranted undertaking in view of more important requirements for administration elsewhere. If, however, a very large seasonal advance is provided in the established price, this would lead to holding for a later period and a scarcity in the market during the early period. The choice of the seasonal must lie in the experience of the past, and some average seasonal derived from recent years will probably prove satisfactory. It is also probable that there would be an advantage in lessening the rise in the seasonal price somewhat below the average with a view of erring on the side of increasing the rate of early marketing rather than retarding it. This would insure the marketing agencies receiving the products at the full rate at which they could be adequately handled, and if only a slight price decline below the established ceiling were induced in the early period, the expected higher later price would tend to balance marketings to the more usual previous rates.

Problems are also raised by the necessity of carryovers from one year to the next. For some products these carryovers are fairly large. The carryover tends to increase when the following crop promises to be small and prices high, and the carryover declines in years when the following crop promises to be large and prices low. The price set or expected for the subsequent year will in consequence have a great deal to do with the extent of carryover during the given year. If the price set for the new crop is materially higher one would of course immediately decide to hold to the later period. Where units of new and old production are distinguishable it may be possible to establish differential prices for them to prevail in the later period. It is possible that usual marketing rates and timing may be considerably upset by failure to gauge this factor. The new situation with ceilings will differ greatly from the old where prices were free to fluctuate. Without ceilings the

outlook with respect to price in the future is uncertain, and holdovers of product may offer considerable advantages even though it appears on current information that prices will be lower in the new year. It is always possible that something will happen to greatly decrease supplies or increase demand at the last moment. Thus a small probable loss is balanced against a great possible gain if the unexpected does happen. Removal of this possibility must necessarily exercise a decided influence upon the propensity of operators to store. Instead of uncertainty and a reward for good judgment, the storage decision now becomes largely established by the price fixing. Storage either would or would not be profitable. In such a situation it may be necessary and indeed probably will be necessary for the Government to enter into the holding of products on a considerable scale and stand ready to buy or dispose of products at the established price.

This review of the problems of agricultural price fixing makes it evident that no predetermined single method will be adequate to do the job required. We cannot afford to freeze agricultural prices at any given level or in any relationship now prevailing. Furthermore, greater flexibility is required than would be obtained by tying prices to parity at any predetermined level.

Agriculture is a vast industry with many ramifications, and the price fixing must be simple and direct unless it is to become completely unwieldy and too complex for administration. The general policy must be one of utilizing the usual regulative forces of the economy to the fullest extent possible. This means that the price fixing authority must be conversant with industry and its markets and be prepared to assist the market to carry out its functions rather than to slap on a fixed set of controls. Fortunately in the accumulated knowledge and experience of the workers in agriculture, particularly in the Department of Agriculture, there is a vast reservoir to be drawn upon, and we may confidently look forward to any legislatively unhampered experiment in price fixing in agricultural products to be carried through with a considerable prospect of success.

IMPACT OF DEFENSE UPON INDUSTRIAL CAPACITY AND INVESTMENT*

By M. Joseph Meehan
Bureau of Foreign and Domestic Commerce

We are now engaged in a war in which our present productive capacity, and the additional capacity that can be brought into opeartion quickly are vital considerations. Therefore, an analysis of the impact of the defense program upon the flow of investment, income, and capacity provides a topic of peculiar interest at this time. An appraisal of the direction and rate of recent economic movements is essential to an understanding of the changes in the structure of industry that are taking place; what we have experienced is a forerunner of what is to come at a vastly accelerated pace as we move into the current all-out effort. I shall endeavor to sketch, in broad outline, the features of what has happened to date, and to give some indication of the implications of these developments.

First, let us take a look at what has happened since the early part of 1940. You will recall that we were then experiencing a mild reaction to the speculative surge which followed the outbreak of war in Europe. The national income in May was at an annual rate of $74 billion, with a large volume of unemployed resources available to speed up the economic machine. Once this driving force was supplied by the decision to expand armaments, it was at once obvious that new facilities had to be created for the specialized production of such goods. Not so obvious were the tremendous demands that would be made in the not distant future upon all our basic resources. Failure to secure general recognition of the latter fact led to much fruitless controversy. What was vital from the standpoint of our present position was the delay encountered in expanding those basic facilities which constitute limiting factors on our productive effort at a time when we are engaged in a world-wide struggle with powerful and resourceful enemies.

The first phase of the defense program extended over a period of a year. The immediate impact on the economy was an acceleration of the tempo of business activity as the added flow of government spending reinforced the demands from belligerents for essential commodities. Expansion at the rapid pace actually witnessed was made possible by the extensive volume of existing facilities that could be drawn into productive operation immediately. A large part of the initial outlays under the rearmament program went for the construction of new hous-

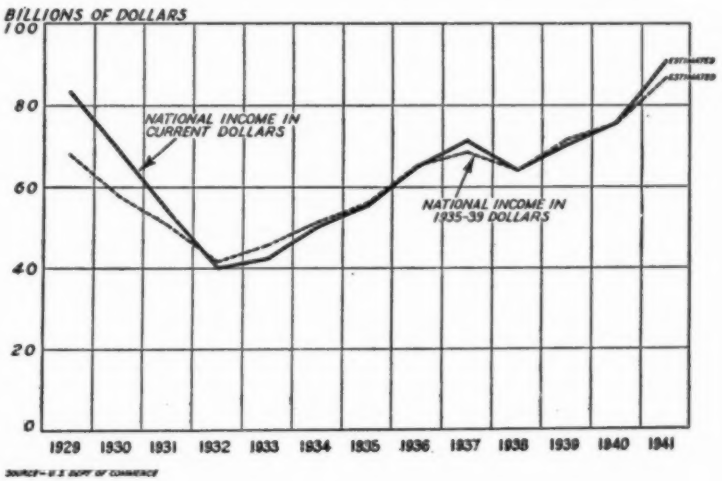
* A paper presented at the 103rd Annual Meeting of the American Statistical Association, New York, December 27, 1941.

ing for the armed forces, for food and other quartermaster's supplies—expenditures that could be stepped up rapidly. This, coupled with the increased pressure for deliveries abroad after the fall of France, and the general change in psychology produced by the events of mid-1940, resulted in an immediate forward movement which was quickly strengthened by the initiation of the broad program of creating new capital facilities.

The result has been a rise in the national income at an unprecedented rate. Notwithstanding that the first half of 1940 was a period of some

CHART I

NATIONAL INCOME IN CURRENT AND 1935-39 DOLLARS



hesitation, for the year we had an increase in income of nearly $6 billion, or 7½ per cent. It is evident from Chart I that practically all of this rise represented an increase in real terms.

During 1941 we have experienced an advance of $16 billion, raising the aggregate for this year to an estimated total of $92 billion. It may be noted that much of this striking increase was in real terms, though the rapid expansion in physical output was accompanied by some rise in prices. In terms of 1935–39 dollars, the rise in income was from $76 billion to $88 billion.[1]

Since the basic expansion was in the industrial segment of the economy, a particularly sharp advance occurred in the output of manu-

[1] These estimates for 1941, and those given subsequently for gross capital formation, were made before full year statistics were available. Subsequent data indicate that the 1941 totals were somewhat higher.

factures which has reached record volumes. The significant thing about this expansion, aside from the over-all rate, is the upward surge in the durable goods industries. When we are creating a "new" industry, or rather a complex of new industries, heavy reliance must be placed upon existing capital facilities. Before long finished armaments will represent our number one industry, and behind the finished products will be the vast organization of men and supply to turn these goods out in a hurry.

The flow of funds stemming from the arms program fanned out through the entire economy. To the demands for producers' goods on the part of the growing armament industry were added the orders from makers of civilian goods who found the time opportune for rehabilitating existing facilities or expanding them in certain instances. Activity was lifted in the producers' goods industries to unprecedented levels—more investment by far was made in new capital equipment in 1941 than in any other year in our history.

I have indicated that this phase of the mobilization of our resources extended through the first year. During that period rapid expansion was fed from existing plants and facilities, mainly through taking up the existing slack. By the middle of 1941, however, we were finding it increasingly difficult to expand production because of widespread bottlenecks in facilities. With this phase began a sharp and widespread price advance.

Additional expansion in output has been achieved during recent months, and we may expect a further rise from now on as new facilities come into production. But the significant thing to note is that we are up against limiting factors—mainly a shortage of basic materials—which were bound to restrict expansion as the tremendous magnitude of the military program made itself fully felt. We have had, therefore, in recent months curtailment in particular lines, with the area of restriction being gradually widened as military demands increasingly impinged upon the civilian sector of the economy.

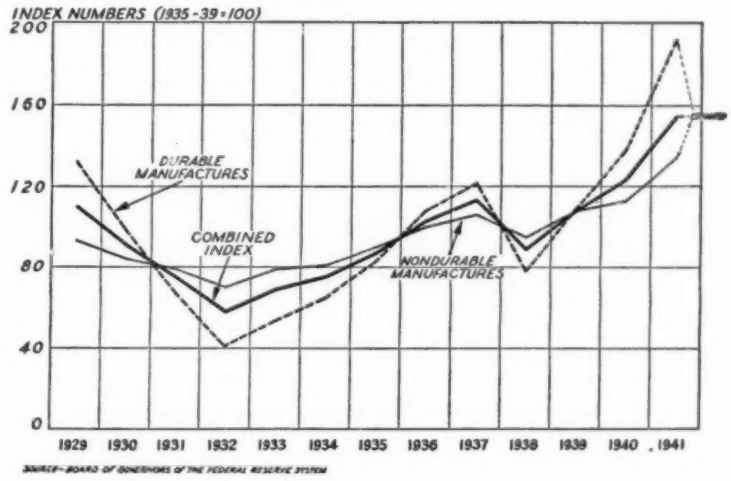
Nevertheless, while we were engaged in what was essentially the "tooling-up" process, we did add very greatly to the supply of goods available to the consumer. We enter a period of restriction of some types of goods, therefore, with larger and better-conditioned stocks than at any time in our history. The process of belt tightening which is ahead finds us well able to stand such a trend.

We may expect that, as output rises further, there will be a very marked divergence from the traditional pattern of output—a phase which is just beginning because up to now consumers have been able to secure wanted goods and thus guide, in more or less usual fashion, the production of goods. It might be noted that, even in the automobile in-

dustry, where the recent curtailment has been pronounced, we produced in the 1941 calendar year 3¾ million passenger cars.

While satisfactory over-all measures of the relation of military expenditures to the total product of the economy are not available, we may accept as a relevant measure a comparison of these outlays and the gross national product. On a rough basis it is estimated that defense, or armament, expenditure as a percentage of gross income has tripled compared with the third quarter of 1940 and now represents nearly one-fifth of the total. Notwithstanding the growth of military

CHART II
FEDERAL RESERVE INDEX OF INDUSTRIAL PRODUCTION



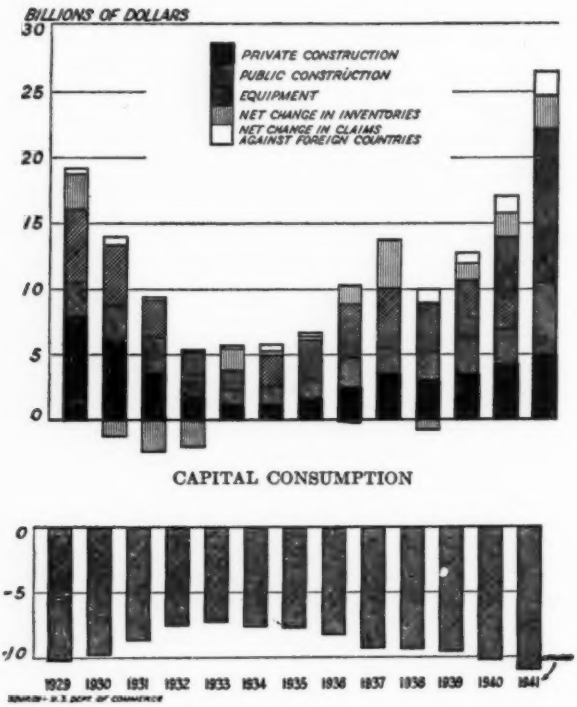
expenditures, a much larger total has still been available for non-military purposes in recent months than in mid-1940 by reason of the expansion in total output previously indicated.

The proportion of military output must perforce grow. Prior to the declaration of war, we estimated that 25 per cent of the gross product in 1942 would be taken by the military program, but these estimates are at present in the course of upward revision. A huge expansion in the war program is now under way.[2] The objective will be to push expenditures as rapidly as possible towards a figure which is likely to move up towards 50 per cent of a much larger total national product.

[2] Expansion of the war program has since taken definite shape in the President's budget message of January 5, 1942. The total war program covered by the message runs to nearly $90 billion, with war expenditure expected to reach a rate of nearly $5 billion per month before the end of the fiscal year 1943.

For purposes of analysis of investment or capital formation, the volume of capital formation has been distributed over five classifications: private construction, public construction, equipment, net changes in inventories, and the net change in claims against foreign countries (Chart III). The first three of these are always positive totals,

CHART III
GROSS CAPITAL FORMATION IN THE UNITED STATES



but the other two have been positive and negative over the period shown here. Inventories represent, of course, a particularly volatile cyclical factor.

For the national income measurement the net volume of capital formation is used—allowance being made for capital consumption. In some years over the period shown in the figure we did not make good our capital depreciation. For the present purpose, however, the series on public and private gross capital formation is the significant one. It should be pointed out that included in the figures of capital formation are the durable products acquired by the Government under the armament program.

What stands out is the magnitude of the 1941 total, and the shifting proportions of this total represented by the various categories. We experienced a rise from $16.7 billion in 1940 to $26.5 billion in 1941. These figures exclude all consumers durable goods, except housing.

Public and private construction together comprised a total of $10.5 billion. This is the same aggregate as in 1929, but the distribution between public and private construction has been radically changed, even more so than the figure indicates since some of the private construction is financed indirectly through public funds. Government expenditures account directly for $12 billion, or not far from half, of the total of $26.5 billion.

While the building of new plants is impressive, what is even more striking is the volume of equipment expenditures. Nothing remotely approaching the estimated total of $11.7 billion has previously been witnessed. Not all of this expenditure is for producers' equipment, since $3.2 billion of durable armaments is included, but the estimated $8.5 billion expenditure for producers' equipment far outstrips like outlays in any other year—it is more than 50 per cent higher than in 1929. Even the very large increase shown for inventories is dwarfed by the equipment totals.

The rise in inventories is a reflection of many factors—one of them being the necessity to stock new plants with materials and in process inventories—but it may be noted that part of it represents a store of goods which can be drawn effectively into the productive process as the armament program is accelerated and conversion of facilities takes on a more rapid tempo. This conversion will be a feature of the next year since it is obvious that further expansion of new facilities on the scale required for the war program is not possible, in view of the limitations imposed at present by materials and which will be reinforced at a later date by limitations on our man-power resources.

Expenditures on military construction and finished armaments will rise rapidly in the next year, but competing types of civilian activity will be very markedly curtailed. Likewise, we may expect the rise in income available for civilian spending to be curbed by the fiscal policy appropriate to the war effort. Investment will be conditioned almost entirely by military considerations.

This was not so true during much of 1941. While we instituted and extended a priorities system after it became apparent that many basic materials were extremely short, it is a fact that general expansion in capital expenditures proceeded along with the expansion resulting from the military program. This stemmed naturally from the high level of incomes which put increasingly large demands upon all productive facilities.

As the year progressed, however, widening priorities controls tended to curtail the flow of machinery orders and the initiation of new plant construction for civilian goods. This is reflected, for example, in new business reported by the machinery industry. From the middle of 1940 through the middle of 1941 there was a wide gap between shipments and new orders, with unfilled orders rising to record proportions. This occurred notwithstanding that the output of producers' machinery and equipment moved up from a monthly rate of $425 million in June 1940 to $700 million a year later. By October, orders had fallen to a level approximating the shipment rate which was then in excess of $800 million a month.

The slackening pace of expansion in non-defense industries in the latter months of the year held the increase in capital expenditures in these areas to a moderate rise over the comparatively high totals of 1940. Nevertheless, it is significant that at a time when the economy was under extreme pressure to expand armament facilities we added to our equipment over a broad section. This was true, for example, in such lines as food and kindred products, textiles and paper.

For the entire year 1941, we estimate expenditures for plant facilities and equipment in the manufacturing industries at more than $4 billion, or about 45 per cent of the total for all industries. In 1940, this proportion was much smaller, the $2.3 billion expenditure for manufacturing facilities representing a more usual proportion—about one-third.

This aggregate investment in manufacturing facilities is three-fourths larger than the $2.5 billion expended in 1918 during the first World War. Today's warfare requires many times the equipment needed in 1917–18, and the facilities behind the lines correspondingly must be greater. The 1941 total is more than 80 per cent above the aggregate for the preceding year. This makes clear the magnitude of the increase in manufacturing facilities, as well as the rate at which expansion has been stepped up.

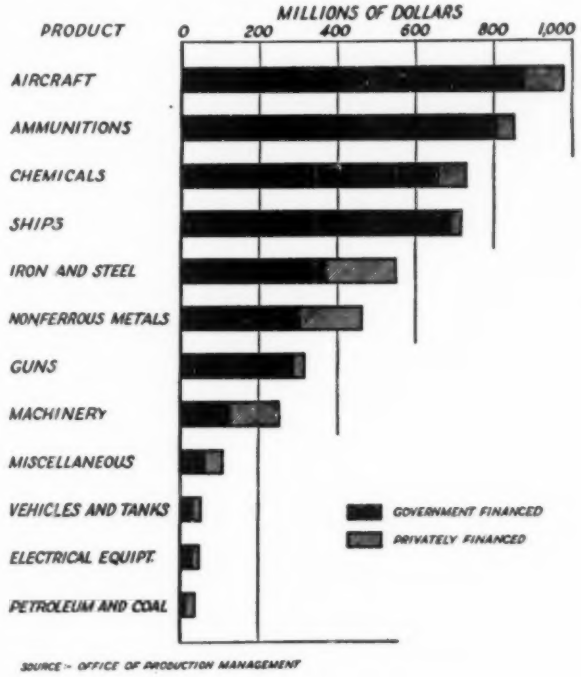
We do not have a good yardstick of total investment in manufacturing industries to use as a measure of the comparative size of the addition to our total facilities. Some indication of its size is afforded, however, by comparison with the net book value of all manufacturing plant and equipment (exclusive of land), estimated at $22.5 billion at the end of 1940. This figure, which is based upon Bureau of Internal Revenue statements of the asset value of corporations reporting for tax purposes, is no doubt an understatement of the replacement value of manufacturing facilities existing at that time. But it is easily recognized that an addition of more than $4 billion in one year, with a higher aggregate certain for 1942, represents an enormous rate of creation of new facili-

ties. We look back upon the decade of the '20's as a period of marked expansion in manufacturing capacity. During that ten-year period, capital expenditures on all manufacturing facilities amounted to $20 billion. In slightly more than two years, we shall have produced half that amount. In all the '30's expenditures aggregated $14 billion.

The distribution of the expenditure for new productive facilities by industries reveals the dominance of military demand. When we break

CHART IV

VALUE OF DEFENSE CONTRACTS FOR INDUSTRIAL FACILITIES FINANCED BY GOVERNMENT AND PRIVATE FUNDS, THROUGH SEPTEMBER 30, 1941



SOURCE:- OFFICE OF PRODUCTION MANAGEMENT

down the $4.2 billion total for manufacturing in 1941, we find that nearly one-half of the expenditure has been in the predominantly military industries; more than one-fourth has been in the basic industries producing for both military and civilian use; and the remaining fourth has gone into industries with predominantly civilian products.

Aircraft led the expansion of the military industries and about one-eighth of the total outlay on manufacturing plant and equipment went into such plants. Chemicals (including powder) and shipbuilding and

repair followed, each with nearly 10 per cent. Ammunition was not far below shipbuilding. The half billion dollars expended in the iron and steel industry equalled the outlay in the aircraft industry.

Expenditures in the machinery industries exceeded a quarter of a billion dollars—half of that expended in the leading industries, and not far above the totals for nonferrous metals and the fuel industry. One-third of the total expenditures in the predominantly civilian industries was made in the food and kindred products industries, one-sixth in the textile industries, and about one-tenth each in the automotive and stone, clay, and glass industries.

The distribution of defense facilities contracts indicates the general picture of the character and extent of expansion in capacity and investment that is taking place. Naturally, these data represent to a considerable extent uncompleted work.

Aircraft definitely tops this contract list with the total of facilities contracts reaching nearly $1 billion by the end of September, a figure now exceeded by the contracts placed in the final quarter of 1941. Again we need a yardstick to comprehend the size of this figure, and we have a reasonably good one in the asset returns of the Bureau of Internal Revenue. One billion dollars was the net value of the corporate assets reported by the automobile industry as of the end of 1938.

Ammunition is second on this list—well over $800 million—though it was in fifth place on the 1941 expenditure list. Chemicals and ships are ahead of iron and steel which shared the top position with aircraft in 1941. The contracts for nonferrous metals reached $460 million. Though the machinery industry is well down on the list, the total represents a very large expansion for this industry. Machine tools probably constitute the most important single bottleneck that exists, and we cannot build all the new equipment needed. We shall have to make much wider use for military purposes of existing equipment of this type. Though this is the case for all the metal working industries, the key importance of machine tools makes it especially significant in this case.

All of the aggregates here shown for military and related facilities will be expanded under the war program, but it is unlikely that the general nature of the expansion will be altered. The military needs will be such, however, that the expansion in non-military facilities on a scale witnessed in 1941 will not occur in 1942.

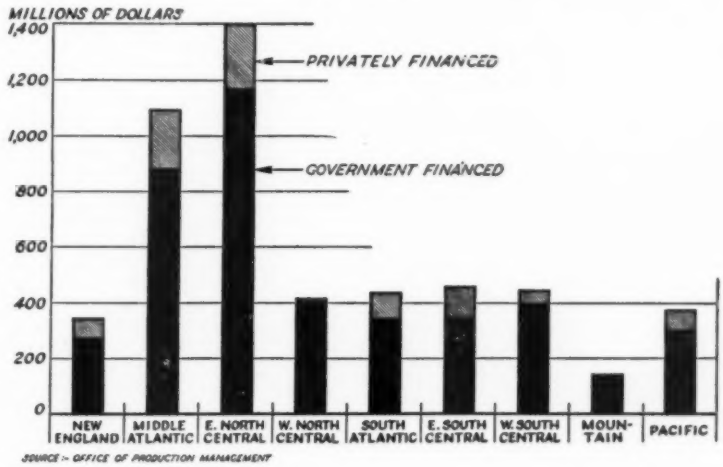
From the middle of 1940 through September 1941, commitments were made for over 3,000 plant expansions by the military authorities. When complete these enlargements are expected to cost over $5 billion. More than $4 billion, or over 80 per cent of this cost, will be met from

public funds, while less than $1 billion will be financed privately. In general, the extent of public financing is relatively greater in those industries where the output is more directly related to armament.

For example, over 96 per cent of the new shipbuilding facilities approved through September are being constructed with public funds supplied through the Navy Department and the Maritime Commission.

CHART V

VALUE OF DEFENSE CONTRACTS FOR INDUSTRIAL FACILITIES, THROUGH SEPTEMBER 30, 1941, BY GEOGRAPHIC REGIONS



More than 90 per cent of the plant for the manufacture of ammunition, explosives, guns, and nearly 90 per cent of the new aircraft facilities are also government financed.

In contrast to this dominance of public funds in financing direct armament plant expansion, only half the new machinery plants and 40 per cent of the petroleum and coal products plants have been directly financed by the Government.

The rapid expansion of military needs has changed not only the structural, but also the geographical pattern of American industry. A rough picture of the geographical shifts occurring in defense industries may be obtained through comparing, by industries and by regions, the allocations for defense plant, and value added by manufacture in 1939. These suggest that as the armament program has developed there has been a moderate tendency for the geographical concentration of industry to decrease.

Those sections which in the past have been most heavily industrial-

ized—New England, the East, and the Great Lakes regions—while still receiving more than three-fifths of the funds allocated for new facilities under the government program, have a smaller percentage of the aggregate new plant than they possessed of the old. On the other hand, states embraced by the grain belt (the West North Central States), the Rocky Mountain region, and the South are improving their relative industrial position even though the expenditure in these areas is much smaller. Note again from Chart V the high proportion of the expansion financed by the Government.

What stands out in the foregoing review is the record addition to our productive capacity in the period preceding the outbreak of war. Further, we may note that we also added greatly to both the quality and quantity of stocks of durable goods in the hands of consumers. This latter fact is important now that we face a period in which war needs will establish the sole criterion for expansion of existing facilities. There are two reasons why we cannot rely entirely upon the creation of new productive facilities to obtain the required output of armaments. The first of these is the excessive drain that would be placed upon raw materials; the second is that we do not have time to complete such a process.

The small amount of finished material that has so far been produced testifies to the fact that our raw material shortages have been the result of the voracious appetite of new construction for these products, and not the result of a rapid rate of embodiment of raw materials in finished instruments of war. Despite record rates of construction, we confront now the major task of converting and adapting, through a process of allocation, existing facilities to war production.

The situation up to recently has been the natural result of a desire to utilize idle resources. Such idle resources may have appeared adequate for the needed *primary* expansion for war material such as airplanes, tanks, ordnance, etc. They have not been, however, adequate for the induced *secondary* expansion, for example, in transportation equipment, in homes, and in other civilian facilities, a large part of which is a function not solely of the primary expansion (as here defined) but of the general rise in incomes that has resulted from that expansion.

At present, in view of the imminence of near complete utilization of resources and the added drafts that will be made upon man power, the problem of increased investment to expand capacity for the war effort is crucial. From this point forward expansion of industrial facilities must be so spread over industry as to maximize the amount of existing resources that can be converted to the war effort. It is clear that war output must be speeded. It is equally clear that this cannot be done by

new plant expansion if the past slower rate of production has strained resources of labor, equipment, and raw materials available for plant expansion and for the building of the whole set of complementary resources that are required by new plants constructed. Therefore, a maximum amount of existing resources must be converted.

The problem is to convert the maximum possible amount of plant and equipment ranging along a scale from the completely generalized to the completely specialized or "one-purpose" units of equipment or plant. The portion of such a scale representing inadequate equipment resources, taken industry by industry, after conversion, is the amount that must be made good by the provision of new equipment. The test of its allocation, therefore, involves the determination of the use that maximizes output of existing equipment by spreading as thinly as possible the new capital resources available. It is this kind of allocation that must be contemplated for every industry considered eligible to undertake war production. Insofar as there may be any expansion of other industries this should be done in a manner to minimize the problems of meeting prospective consumer demand and of effecting the transition back to peacetime production.

THE PROBLEMS OF DETERMINING FAIR RENTS*

By Karl Borders
Office of Price Administration

In war time the formulation of fair principles of rent control for housing accommodations involves consideration of the interests of three principal parties to the rent contract: the landlord, the tenant, and the Government. Driven by the exigencies of total war, the Government cannot now permit the free operation of landlord-tenant bargaining, when the result of this bargaining contributes to inflation and impedes the smooth functioning of labor recruitment in defense centers.

Through the services of the Bureau of Labor Statistics and the Division of Research of the Work Projects Administration, rental trends are now being surveyed and charted in more than 230 defense localities. In most of these areas vacancy of rental housing accommodations has become negligible, as a result of a number of concomitant factors. (1) In-migrant workers have come to take newly-created jobs in defense industry. (2) Expanded employment has raised the economic status of many families who had previously lived in crowded quarters. Such families can now afford to "undouble" and are seeking separate accommodations. (3) Families of officers and enlisted men have moved to areas near military posts. (4) The marriage rate has risen and further increased the demand for separate dwelling units. (5) The housing stringency has caused a transfer of rental housing to the sales market, further limiting the supply of units available. (6) Because of increased costs, construction of rental housing for workers has become an even less attractive form of investment than it was before the war. (7) Priorities on housing have begun to curtail new construction in an absolute sense.

So great is the pressure of this demand for rental housing that in scores of localities, despite the exertions of private building and the allocation of defense housing, there is no prospect of anything like a free, competitive market for the duration of the emergency. The upward spurt of new construction during '39, '40 and '41 cannot be sustained. Yet the total number of dwellings built during this active period was far from adequate to compensate for the paralysis of the construction industry during the depression of the '30's. In the future we may expect the continuance of migration from non-defense to defense centers, despite efforts at the dispersion of war contracts.

For the country as a whole, the rent index of the Bureau of Labor

* A paper presented at the 103rd Annual Meeting of the American Statistical Association, New York, December 28, 1941.

Statistics for wage earners and lower-salaried workers, based on reports from 34 large cities, has shown only a moderate upward tendency: from September 1939 to October 1941 it rose only three points and even this upward movement is a reflection of increases in metropolitan centers such as Jacksonville, Buffalo, Detroit, Baltimore, Mobile, Indianapolis, and Cleveland, which are defense areas. Against this national pattern, the individual defense center presents a sharply contrasting picture.

From surveys of defense centers thus far completed, it appears that since October 1939 at least four cities with a population over 50,000 have shown an index rise of ten points or more, and 21 cities an index rise of from five to ten points in the total rent bill. From data available, there is reason to believe that, unless statutory controls are imposed, the general upward movement in these larger defense centers will continue throughout the emergency, with obvious consequences: (1) A lowered standard of living for those with comparatively fixed incomes; (2) A tendency to increase the labor turnover and encourage needless migration; (3) An impetus to demands for compensatory wage increases.

Defense localities under 50,000 had an insignificant number of vacant dwelling units at the beginning of in-migration. The large cities had some leeway. In the smaller communities defense activity brought an almost immediate and complete upheaval of the previous rental structure. This resulted in increases in the total rent bill which amounted in at least one instance to 100 per cent for the period March 1940 to September 1941. For all surveys thus far reported, the index has risen 5 to 15 points in 36 localities; 15 to 25 points in 14 localities; 25 to 35 points in 7 localities; 35 points and over in 4 localities in approximately the same period. It does not seem probable that in small defense communities an upward movement of this magnitude will continue indefinitely. The saturation point has probably been reached in some cases. After all there is a limit to what workers will pay for a broken-down shack, since they still have the ultimate choice of moving away from the area. In these communities the Government is confronted not only with the problem of stabilizing rents but of actually reducing them.

Since the need for rent control does not have to be established, the problem is primarily one of method. Whatever the factors considered, one basic principle should be determinant: The formula must have simplicity. An administrative order for rents cannot bear any resemblance to a price schedule for a highly organized industry which employs experts to deal with complicated forms. In the case of rent control, literally millions of landlords and tenants must understand their rights and duties.

The landlord's formula for determining fair rents is traditional. He

believes that he is entitled to a fair return on his investment, or to a fair return on the market value of his property. Such criteria were used in the two most significant American rent control experiments of the last post-war-period—in New York State and in Washington, D. C. The inadequacy of the results was obvious. Each piece of rental property became a potential public utility case. The administration bogged down. In an attempt to be fair to every individual, the entire program became futile.

It has also been suggested that a relationship be established between an assessor's appraisal of a rental property and a fair return. But those familiar with the pattern of municipal assessment plans and practices must realize that such a system would be built on sandy—if not swampy—ground.

In addition to fair return on investment, which implies an excursion into financial history, and fair return on a market value, which in itself is subject to inflationary influences and directly related to the rents to be controlled, there has been another proposal; the plan of those whom we may call the classifiers. They would like to establish classes of units in terms of size and character of structure and other variables, and set fair rentals for each class or category. This plan would be a delight to a real property inventory expert, but a nightmare to an administrator. So numerous are the variables in terms of age, condition and location, that any attempt to make a pattern out of the housing of an American industrial city would be doomed to failure. And even if it could be done, it would serve no purpose. A schedule of classes and rates in which the tenant does not quite know where he belongs would be useless.

Hence, by a process of elimination if not by preference, we arrive at the rent ceiling date method. This is the principle now being used by the voluntary Fair Rent Committees established under the direction of the Office of Price Administration; this method will go into effect January 1, 1942, in the District of Columbia under statutory powers; and it is basic to the rent sections of the proposed Emergency Price Control Bill. Under this method, the authority chooses a date at which rents are generally pegged for the duration of the emergency or as long as a free rental market remains inoperative, with allowance for the adjustment of hardship cases, to both landlord and tenant.

But the practice of fixing of the ceiling date is not quite so simple as the statement of the principle. Under ideal circumstances, at the very beginning of the emergency the ceiling date should have been imposed upon any locality where it was fairly obvious that the impact of the defense program was about to, or had already begun to, result in an inflationary rent movement. In most defense areas that would have

meant pegging rents in the spring or fall of 1940. The Canadians began pegging rents in selected defense localities as of January 2, 1940. We, unfortunately, have thus far had no statutory authority. Fair Rent Committees exert a psychological effect in restraining an extreme inflationary trend; they do not stop the trend, and they certainly cannot be expected to reverse a movement which is already under way. The results of this absence of statutory rent control authority are reported regularly in rent surveys.

At the present moment there is every likelihood that the Emergency Price Control Bill will include sections for the regulation of rentals in defense areas. Though the specific provisions are still before Congress, it is possible to discuss some of the problems which would be involved in setting a rent ceiling date. In fixing the ceiling date in a given defense-rental area, it would be wise to take into consideration the rents prevailing in that area on some pre-emergency date. April 1, 1940, would serve as a convenient benchmark; first, because it is the date of the Housing Census and data are available on vacancy, rent levels and type of structure for all units in the country; and second, at that time hardly any areas were yet significantly affected by the defense program, the only possible exception being a few shipbuilding centers. Having adopted a base date, it would be necessary to ascertain, so far as possible, what had happened to the operating costs of various types of housing accommodations in defense areas subsequent to that date.

From our preliminary soundings, it does not appear that in the upkeep of the dominant types of rent units in defense areas—the small one and two-family houses—there have been extraordinary increases in operating costs. There may be some—and we are tackling this problem through actual surveys of expenses from management books and through spot surveys of informed opinion where management books are not available—but there are not enough increases in general to justify a substantial advance in rentals. The facts are that in an area where the vacancy ratio is nil the landlord does not have to spend as much for upkeep as he would in a competitive market.

Thus, increased operating costs, the standard justification for most price increases, do not appear to affect rentals significantly during this period. Apartment houses which have had their fuel, repair material, and labor costs increased may show some rise, but (a) apartment houses are not a significant proportion of rental housing accommodations in most of the defense areas where problems are acute; (b) substantially increased occupancy will make up for increased costs in a unit cost analysis of upkeep expenses.

It will be necessary to continue gathering any available data on the

operating costs of rental housing from insurance companies, Government agencies, private foundations, as well as from a sampling of management books in selected defense areas, but, at best, these data will be straws in the wind. In practice it will probably be difficult to develop precise correlations between the rental movement and the upkeep costs of rental housing in a given area.

The setting of the rent ceiling date will, therefore, require administrative discretion, an analysis of each individual area, and a consideration of all the demand factors which have affected the movement of rentals in the area. It would probably be wise to set the rent ceiling date sufficiently far back to rescind as many of the exorbitant increases as may be feasible under sound administration. On the other hand, it will hardly be worth while to go back as much as two years if we peg rentals in a large metropolitan area where there has been a slow but steady rise. Among other reasons, because of tenancy changes and conversions, there would be an extraordinary number of disputes over the actual rental prevailing on the ceiling date. The administration would thus start off with controversy over the initial fact of what the fixed rental is. In small communities where the defense program has resulted in sudden profiteering increases—as indicated in an index rise of 40 or 50 points—it may be necessary to go back as far as April 1940 in order not to freeze rents at an exorbitant level.

Once a ceiling date is set for a locality, an administrator would be confronted with the problem of assuring tenants occupancy of their accommodations. Restriction of evictions is basic to any system of rent control. In the conversations which I had sometime ago with representatives of the Canadian Rentals Administration, they were very emphatic on this point. True, under a rent pegging system the landlord may not receive a rent above that in effect on the ceiling date, but if the landlord can at will order tenants to move, threat of eviction may prevent a tenant from registering complaint against a landlord violating the Act. Naturally, under any system the landlord should be able to regain possession of his property if he needs the dwelling for his own use, or if he plans a significant program of remodeling; but the tenant must be secure in his occupancy so long as he pays the legal rent and complies with other normal requirements, if he is to feel free to take advantage of his rights under the Act.

Furthermore, in any administration of rent control in a defense-rental area allowances should be made for individual hardship cases. This provision of flexbility would eliminate gross inequities. If, for example, on the ceiling date a landlord had rented to a relative at an

uneconomic rent, it is fair to allow him an upward adjustment when he rents on an economic basis. Likewise a tenant who for some peculiar reason was paying an exorbitant rent on the ceiling date should be given an opportunity to appeal for a decrease.

For units of new construction and converted units which were not rented on the ceiling date, the best administrative guide is the principle of comparability, with consideration of increased construction costs where they have occurred. What was the rent for a comparable unit in the locality on the ceiling date? This immediately raises the question as to how one determines comparability in individual cases. The only answer is that comparability in individual cases will be made on the basis of expert opinion by local informed inspectors, the same type of expert opinion which is accepted in appraisals.

Adjustments should also be made for any capital improvements effected subsequent to the ceiling date. The cost of these improvements should be pro-rated over a reasonable length of time, and the landlord should be allowed a fair addition to the rental.

Along with the freezing of rents on the ceiling date, there should be a freezing of all services which were a part of the rent contract, whether it was written or oral. Should the landlord reduce the service standard in effect on the ceiling date, the tenant ought to be given the right to appeal to the local administrator for a downward adjustment of his rental, since a reduction in services is plainly equivalent to an increase in rents.

There should also be provision for periodic raising of the rent ceiling when it can be shown that there has been a general rise in the cost of operating rental housing in a given defense area. Though at the present time there is no indication of any sharp upward movement in operating expenses, there may be in the future. After the adoption of the base date for a given area an administrator should collect all available relevant economic data, and if there are significant increases in operating and maintenance costs, he should issue an order granting the whole defense locality a specific percentage increase in rents above the base. Any such over-all allowance would, of course, necessitate an estimate of the ratio between total rent receipts and operating expenses. These ratios vary sharply from one area to another. In general, a showing of a substantial rise in over-all operating costs would be necessary before as much as a 5 or 10 per cent allowance above the rent ceiling is permitted.

Under this plan of rent pegging as of a given date, both landlord and tenant are allowed to continue the basic economic relationship which prevailed on a reasonable date after the emergency was declared. A

landlord simply would not be permitted to take undue advantage of a severe housing stringency and what amounts to a monopoly market which has resulted from defense activity.

It is obvious that any system of rent control will result in successful evasion in individual instances. (1) Because of the complete absence of rental vacancy, there may be collusion between an individual landlord and an individual tenant who may agree upon a rental above the ceiling. (2) Sales contracts may be devised which in reality amount to no more than an increase in rental. (3) There may be a general tendency to reduce services and repairs. As each of these problems arises, a wise administration will have to devise new regulations and methods to cope with attempts to circumvent the law.

On the whole, I feel that such a system of controls is likely to work out better than any previous attempts, because it is simple and because it places the burden of proof for revision upon the landlord, who has easier access to the forms and practices of administration than most tenants.

One last word on the effect of rent control upon the supply of housing in defense centers. It is an old argument that rent control will impede the progress of private construction where it is most needed. This contention becomes ever more academic as priority demands on critical materials become ever greater. However, if the only way to get new private construction is through an agreement to allow an exorbitant rental, then the job of providing housing for defense workers will have to be done by public construction of defense housing. But in my opinion a strict regulation of housing construction, so that it actually supplies the absolute needs of defense workers and not the luxury requirements of other strata in the population, can go hand in hand with a firm policy of rent control.

THE EFFECT OF THE FULL MOON ON TROUT FISHING*

By C. McC. Mottley and Daniel R. Embody
Cornell University

THE SITUATION that is to be explored, the effect of the full moon on trout fishing, is one that might easily give rise to superstitious beliefs. In approaching it one is immediately confronted with the question of selecting an appropriate method of inquiry. The scientific method is suggested as the best way of attaining knowledge and testing beliefs on any subject. Scientists—and statisticians—seem to speak as though it were a single method universally understood and used. Upon observing scientists in action, and after listening to their controversies, one might conclude, however, that different workers use different methods.

The method actually employed in a given situation seems to depend on the attitude of the individual toward his objective; many are extremely vague about it, some attempt to explain phenomena, others try to describe Nature, some seek the most precise statement of laws, many pursue Truth; not all would agree that the scientist should not only produce sound beliefs but produce them in such a way that the conclusions can be tested by the community. It is evident that many workers have never seen any need for stating their attitudes or habits of research; some would even deny any such necessity.

R. A. Fisher once made the statement that the statistician's function is to make sense out of figures. If this idea is expanded then the scientist should make sense out of such situations as the one which now confronts us. According to this view the scientist inquires into situations that do not make sense on first examination and, in so doing, he changes the state of affairs so that it does make sense. If it turns out in the long run that the community agrees with him, after trying out his conclusion, then it is judged to be a sound belief, but it is always subject to revision as more information comes to light.

The transformation of the elements of an indeterminate situation seems to proceed through a series of steps and appears to follow a fairly definite pattern. In a biometric inquiry, for instance, certain operations are needed to get from one step to the next, but the principles which control these secondary operations are usually suppressed or are taken for granted in accounts of individual research. If everyone used the same method, if, in fact, the scientific method were a single method, then taking such things for granted might be beyond question. If, on

* A paper presented at the 103rd Annual Meeting of the American Statistical Association, New York, December 29, 1941.

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The transformation of the elements of an indeterminate situation seems to proceed through a series of steps and appears to follow a fairly definite pattern. In a biometric inquiry, for instance, certain operations are needed to get from one step to the next, but the principles which control these secondary operations are usually suppressed or are taken for granted in accounts of individual research. If everyone used the same method, if, in fact, the scientific method were a single method, then taking such things for granted might be beyond question. If, on

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the contrary, different methods are used, and if the kind of belief produced depends on the means employed, then it becomes a matter of fundamental importance to state the method by which conclusions are reached.

The purpose of this paper is to draw attention to the necessity for keeping the directing principles that are employed in research as open to public inspection as the data, the evidence and the conclusions. In doing this the hope is entertained that it may help to do away with many of the conflicts which flare up between workers and aid in the critical scrutiny of results by the scientific community which is an essential part of the process of producing sound knowledge. The procedure will be to draw attention, briefly, to the more important operations needed to resolve an indeterminate situation and then each operation will be applied to the situation.[1]

THE INDETERMINATE SITUATION

Operation: becoming aware that known and unknown elements exist, characterizing the situation as problematic and expressing the need for inquiry.

Example: In recent years the fishing alibi has taken an astronomical trend and many explanations for poor fishing have been offered to the angling public. One of these notions is that trout fishing, even though it is carried on during the daylight hours, is adversely affected at the time of the full moon. No doubt this belief has been borrowed from marine fishermen. In the sea the effect is a real one probably related to tidal influences which are definitely associated with the phases of the moon. The existence of such a relation in freshwater appears to be doubtful. In any case inquiry seems to be needed before the idea is used to condition our trout fishing habits.

DATA

Operation: obtaining data from the situation, which is characterized as doubtful, by making observations and converting the material into symbols having both representative capacity and the power to indicate the exact problem.

Example: The idea that the full moon had an adverse effect on the fishing first became general at Paul Lake in central British Columbia after the 1934 season. In the course of fishery management studies from 1932 through 1936 catch records were kept at the single boat livery. The number of boats fishing each day and the number of rainbow trout, the

[1] Our indebtedness to John Dewey, *Logic: The Theory of Inquiry*, for the general pattern is acknowledged.

only fish in the lake, caught during the open season from May 1 through October were recorded. Over 27,000 rainbow trout representing about two-thirds of the total catch from the lake were counted. These data which are available at the Laboratory of Limnology and Fisheries, Cornell University, provide certain facts upon which the issue of the effect of the full moon may be investigated.

THE PROBLEM

Operation: establishing logical control of the situation by circumscribing and locating the particular problem presented by the data. The particular problem is: such a difference as that observed might occur by chance.

Example: A preliminary survey of these data indicated that there seemed to be a reduction in the catch at the time of the full moon in 1934 which might easily have given credence to the belief that the full moon does affect the fishing; but we want to know if there is a general effect operating consistently over a period of several years. The particular problem indicated may therefore be stated thus: was there a significant difference in the catch of rainbow trout at the time of the full moon during the six-month fishing season of the five-year period at Paul Lake?

THE POSSIBLE SOLUTION

Operation: formulating the hypothesis indicated by the data and by the exact statement of the problem. In this case chance could provide a reasonable explanation of the difference.

Example: The most plausible solution to the problem is: although variations will be found in the catch from month to month and year to year, the differences at the time of the full moon will be no greater than would occur merely by chance. In other words the difference in the catch between the two periods is not significant. If the uncontrolled variation in such situations as this (chance) forms a normal distribution then the hypothesis may be developed thus: if a hypothetically infinite population of such catch records as these gives a normal distribution with parameters, *mu* and *sigma*, then the efficient statistics, mean and standard deviation, from a population such as this one are estimates derived from a similar distribution. From these statistics it may be deduced that, if a certain variance ratio (F) is given by statistics from a normally distributed population, then the value of f to be calculated from the data is such a value as would be derived from statistics from a normal distribution. It is understood that the data are to be "normalized" in case they do not approximate the normal distribution. It is also

stipulated that the evidence is to be judged by the null principle. This stipulation converts the hypothesis into a null hypothesis.

THE DESIGN

Operation: specifying the material and the logical principles to be used in maintaining control and providing a valid test.

Example: In order to test the proposed solution of the problem, representative data were selected from the records. The week of the full moon was separated from the rest of the month; the day of, the day before and the day after the calendar date of the full moon were selected as representative of this condition. Three days were selected at random from the remaining days in each month. The number of boats fishing and the number of trout caught on each of the selected days in each of the six months in each of the five years were tabulated. The standard design for an analysis of covariance was judged to be suitable for controlling the conditions and producing the evidence, including the estimates of error, necessary for the tests of significance.[2] Since prior inquiry had shown that the mean and variance of data of this type are correlated the original data were "normalized" by transforming them to square-roots. The null principle requires, first, the prior choice of limits of significance and, second, the decision to abide by two stipulations. Since little is known about such situations as this one, it was decided that a high level of significance, the one per cent level, should be adopted. The two stipulations to be used in judging significance may be stated as follows:

1. If the value of f falls beyond the one per cent level, then both clauses of the hypothesis are denied and the hypothesis is refuted. In which case chance could not reasonably supply the sole explanation of the difference. The difference will be judged to be significant and the situation will be determinate.

2. If the value of f falls within the one per cent level, then the consequent clause is affirmed, but this does not necessarily confirm the whole hypothesis. Chance could, therefore, reasonably be offered as an explanation for the observed difference. In this case the situation is still indeterminate and further inquiry is needed in order to make final judgment, but this does not prevent an evaluation of the practical significance of the difference.

THE CONTROLLED INTERACTION

Operation: the controlled reduction of the interacting symbols which represent the data. This step is introduced because the reduced data

[2] Symbols and procedure used follow George W. Snedecor, *Statistical Methods*.

may be used to produce evidence other than that required for this particular problem; e.g., tests for differences between months or years.

Examples: The standard procedures for the analysis of covariance were put into operation for controlling and reducing the material specified in the design. Variations in the number of boats were con-

TABLE I

THE REDUCED DATA FOR THE NUMBER OF BOATS FISHING (x) AND THE NUMBER OF FISH CAUGHT (Y)

Source of variation	Degrees of freedom	Sums of squares and products		
		Sx^2	Sxy	Sy^2
Total	179	130.85036	247.53364	1129.36166
Years (A)	4	3.37352	22.74489	158.50487
Months (M)	5	16.17792	32.53908	135.95300
Period (T)	1	0.23472	0.02925	0.00365
$A \times M$	20	17.40682	55.92297	242.47799
$A \times T$	4	1.04625	3.93156	17.58921
$M \times T$	5	0.65436	2.21361	16.65734
$A \times M \times T$	20	7.20790	21.51251	101.52506
Sampling error	120	84.74887	108.63977	456.65054
Combined interactions	49	26.31533	83.58065	378.24960

trolled by the methods of regression; variations in the catch associated with the main effects, namely, the different years, the different months, the two conditions of the moon, and the various interactions were controlled by means of the independent classifications in the analysis of variance. The reduced data in the form of sums of squares and products are shown in Table I.

THE EVIDENCE

Operation: producing the required evidence from the reduced data.

Example: The evidence in the form of errors of estimate and variance ratios are shown in Table II. Since none of the interactions is signifi-

TABLE II

THE DEGREES OF FREEDOM (*d. f.*), THE ERRORS OF ESTIMATE (Sy^2), THE VARIANCES (Vy) AND THE VARIANCE RATIOS (f) DERIVED FROM THE DATA IN TABLE I

Source of variation	*d.f.*	Sy^2	Vy	f
Combined interaction	48	112.78741	2.34974	
Periods + interaction	49	114.95374		
Difference for testing	1	2.16633	2.16633	0.9219
Months + interaction	53	196.88652		
Difference for testing	5	84.09911	16.81982	7.1581
Years + interaction	52	155.96763		
Difference for testing	4	43.18022	10.79504	4.5941

cant the combined interaction term was selected as the basis for comparison.

THE TEST OF SIGNIFICANCE

Operation: the inductive inference.
Example: The value of f calculated from the data is less than the appropriate value of F in the tables of the F-distribution; the difference between the catch at the time of the full moon and the catch on days selected at random is, therefore, judged to be not significant.

WARRANTED ASSERTION

Operation: final judgment.
Example: As far as the evidence goes the samples from both periods could have been drawn from the same normal distribution. It may be concluded that this evidence does not show a significant difference in the catch of rainbow trout at the time of the full moon. According to the null principle, the possible effect of the full moon on trout fishing is still open to question.

UNIFIED SITUATION

Operation: final judgment prepares the situation for further inquiry or the criticism of the community, from which it may emerge as a contribution to knowledge. If it is judged to be a sound belief, it may then be used in further inquiry, or it may be put to direct use and enjoyment.
Example: The inquiry shows that the difference between the catch at the time of the full moon and the catch at other times, is not statistically significant. Chance variation could thus provide a reasonable explanation of the differences. The moon may have an effect on the fishing but, if so, it does not seem to be great enough to be of practical importance. If one were prepared to act on this belief, and if he had a choice of several days on which to go fishing at this particular lake, he should not let the phase of the moon influence his choice; furthermore he should not use the phase of the moon as an alibi in case he "enjoyed" poor fishing.

Space does not permit a detailed exposition of all of the principles connected with the controlled transformation of an indeterminate situation into one in which the constituent distinctions and relations are unified. In order to indicate what is meant we should like to discuss only one of the operations in more detail.

The formulation of the hypothesis is of strategic importance because, in the one direction, it represents, in the form of an explanation, the complete convergence of the relevant information contained in the

data; in the other direction, it rigorously controls the specifications to be stated in the design. The hypothesis therefore determines the validity of the test but only if it is explicitly stated in the "if parameters, then statistics" form. If the null principle is not included explicitly in the statement of the hypothesis, then it has to be understood as being a part of the attitude of the worker.

The possible solution for the problem was first stated in the form: "the difference in the catch between the two periods is not significant." Judging from the way problems and hypotheses are presented, if stated at all, in current biometrical literature, such a statement is usually considered to be adequate. If this attitude is adopted, it means that the exact test and the principles which determine the validity of the test are left to be understood, and confusion may follow. One can only trust that the investigator has been aware of the implications and is competent to handle the situation.

ESTIMATING LABOR REQUIREMENTS*

By Donald H. Davenport
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Within limits the total labor supply is capable of expansion or contraction. At the present time the total "normal" labor force would be about 55½ million. This number increases normally with population growth, at the rate of about 700,000 per year. However, within a short time the total can probably be expanded to well over 60 million. Young people can be persuaded to enter the labor force at an earlier age than usual; older workers can be persuaded to work beyond the time when they would usually retire; housewives may accept industrial employment on a part-time or full-time basis in addition to caring for their homes. By all of these means the effective labor force can probably be increased by as much as 10 to 15 per cent above normal levels. World War experience confirms the conclusion that under war conditions the labor force can be expanded considerably beyond its "normal" size.

This potential labor force probably exceeds the number we will be able to put to work in the immediate future. Limitations in materials and plant facilities restrict our ability to utilize our total labor supply. Even with the tremendous expansion in our armed forces which we may now anticipate there seems little likelihood that we will find our war effort limited by the size of the *total* labor force. While it seems unlikely that our *total* supply of available manpower will set limits to our war effort, there remains a tremendous problem of labor training, transfer, and adaptation. The workers who can be drawn into the labor force do not constitute a trained and experienced reserve. When men are drawn from industry into the armed forces, their replacement with inexperienced workers necessitates training and adjustment. Experience in Germany, later in Great Britain, and currently in America demonstrates that materials, productive capacity, and management bottlenecks can be progressively broken and that the ultimate limiting factor is the rapidity with which the skilled labor supply can be increased. The material and plant capacity bottle-necks allow time for the adaptation of labor resources to be worked out. Once these other bottle-necks are broken the labor shortage bottle-neck becomes acute. It is important, therefore, to look ahead and see what the prospective needs for labor are with respect to numbers, to skills, and to geographic location; and what steps can be taken to meet those needs with our labor supply.

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In this general situation estimates of labor requirements for the defense program serve two broad types of purposes:

(a) The first is to give to all groups concerned—employers, labor, and the public—a general picture of the size and importance of the problem of labor training and readjustment. After a decade of unemployment it was difficult to conceive of a situation where trained labor was to become a scarce resource. Employers, labor, and the public were slow to recognize the possibility of labor shortages and the need for pushing ahead a program of labor adaptation. The attitude of employers, labor, and the public toward prospective labor shortages tends to be a function of the immediate circumstances affecting labor supply, and changes only as circumstances change. In September 1939, when the war broke out in Europe, there were about one million fewer workers employed outside of agriculture than had been employed in 1929, notwithstanding the addition of approximately 6 million to the labor force in the intervening 10 years. Employment in all major industrial lines except shipbuilding and aircraft was below the 1937 peaks. With so many unemployed, employers could get all the workers they wanted at the factory gates. It was natural, therefore, that they were not particularly concerned with training or with the possibility of future labor shortages. By the winter of 1940 employment in the manufacture of machine tools, iron and steel products, and machine shops had exceeded 1937 employment peaks, but such important industries as steel, agricultural implements, automobiles, railroad cars, and chemicals were still experiencing employment levels below those of 1937. Until well into 1940 most industries could find all the skilled workers they needed merely by rehiring workers that had worked in those same industries in 1937. The notable exceptions were the airplane, shipbuilding, and machine tool industries. Even these industries, however, experienced no real difficulty in recruiting labor during the first half of 1940. They simply hired workers from among those who had been laid off in other industries. Under such circumstances the estimating of future labor requirements served a valuable function in getting employers to anticipate their needs.

Similarly, labor seeing considerable numbers of persons still unemployed was somewhat reluctant to accept the necessity for an expansion of apprenticeship training, and retraining programs. Information on anticipated labor requirements was of considerable assistance in securing labor's acceptance of the labor adaptation program. It also helped to impress on employers the need for developing adequate programs of apprenticeship and in-plant training. Public acceptance of the need for programs such as those indicated can best be obtained by comprehen-

sive information regarding future labor requirements as compared with the numbers of workers in various occupations still seeking employment.

(b) The second purpose of labor requirements estimates is more specific. For program planning purposes, we need to know *what kind* of workers will be needed and *where*, in order that training and recruitment policies may be planned in advance to meet the specific needs which will arise. It is useless to train workers for occupations in which the supply is already adequate to meet the need, or to train the right kind of workers in the wrong place. This suggests a further use of the estimates in connection with the planning of the location of new defense plants, and the planning of training programs for defense workers. For all of these phases of the defense program, a detailed knowledge of future labor requirements is essential to effective planning.

OVER-ALL ESTIMATES

In the early stages of the defense program, the only data available as a basis for estimates of labor requirements were the total amounts authorized by Congress for the production of military and naval equipment. On the basis of these over-all totals, it was possible to make rough estimates of the total number of man-hours or man-years of labor required to fulfill the authorized program. Thus in October 1940, the Bureau estimated that of the 10.4 billion dollars then authorized for defense, 9.3 billion dollars would be spent for manufactured goods and construction work, and that this would involve an aggregate of roughly 4.5 million man-years of labor. Until this production had been scheduled, month by month, only the roughest guess could be made as to the rate at which these man-years would be expended, and the resulting effect on the level of employment. But, taking into account the many intangible factors involved, it was estimated at that time that *defense* production would require an addition of "3 and possibly 4 million workers by the end of 1941," and that the indirect effects of this expenditure would increase non-defense employment by about 2 million.

Additional defense appropriations have materially increased the rate of expansion during the period covered by this initial estimate. The increase in defense employment during the 18-month period from June 1940 to December 1941 is now estimated at about 4.5 million. As a result of the increasing tempo of the defense program, the expansion of non-defense employment was halted in the third quarter of 1941. The increase in total employment, however, will easily fall within the range of 5 to 6 million suggested in the original estimate.

When the defense appropriations materialized in the form of defense

contracts and when detailed production schedules became available, more detailed and more accurate estimates of labor requirements became possible. But as ever-increasing appropriations were piled on top of existing authorizations, such schedules were necessarily in a continuous process of revision. And at these higher levels, the levels of production and employment became increasingly dependent not merely on the demand for goods but also on the limitations of plant capacity, materials, and trained labor. We had not then and we have not yet reached the point where these factors set abolute limits to the expansion of defense production. But the provision of additional plant, the re-allocation of raw materials, and the training and absorption of skilled labor all take time. All these factors promised to restrict, not our total production, but the rate of its increase, after the middle of 1941.

Taking these factors into consideration in June 1941 the Bureau estimated an increase in non-agricultural employment of from 2.5 to 3 million in the year ending in June 1942. This compared with an actual increase of over 3.5 million which had taken place during the preceding 12 months, when shortages of capacity, materials, and skilled labor were virtually unknown. During the first six months of the year covered by this estimate (through December 1941) the increase (affected to some degree by seasonal factors) will be about 2.2 million. As of December 1941, we see no reason to modify this estimate. It seems unlikely that total non-agricultural employment will rise by more than 0.8 million from December 1941 to June 1942.

With the rapid expansion of defense production and the curtailment of non-defense production impending, there arose a demand for estimates of "defense employment." This involved not only difficulties of estimation but also difficulties of definition. Finished products may be fairly readily allocated to "defense" or "non-defense" categories. But the total labor entering into the fabrication of any given product includes man-hours in mines, railroads, power plants, and steel mills, as well as in the plant where the final assembly takes place. And since most of this indirect labor contributes to the production of both "defense" and "non-defense" goods, its proper allocation becomes essentially a problem of national "cost accounting" in terms of employment.

Any such problem of cost accounting involves a certain degree of arbitrariness in the allocation of joint costs. Joint costs, in this case, present problems in all industries whose output is going partly to defense and partly to civilian uses, but these problems are particularly acute in such industries as transportation and power, where employment is affected much less than proportionately by increases in output. It was felt to be anomalous, for example, to allocate any substantial

proportion of the employment in the transportation and public utility group to defense at a time when employment in this field had increased only slightly, despite a considerable apparent increase in both defense and non-defense "output."

Thus certain more or less arbitrary "cost accounting" conventions were adapted in defining "defense employment." Physical output in each industry group is first broken down into its defense and non-defense components. Employment in a "pre-defense" period (we have used the second quarter of 1940) is allocated proportionately to defense and non-defense categories on the basis of the corresponding allocation of production. The employment and production data for each quarter are then compared with those for the pre-defense "base" quarter. If non-defense production is above the base level, the employment *increase* (if any) is allocated proportionately to the production increase to the defense and non-defense categories. If, however, non-defense production is below the base quarter, non-defense employment is regarded as having declined proportionately, and the remaining employment allocated to the "defense" category. On this basis, an estimate of defense employment for the fourth quarter of 1941 will be about 5 million, as compared with roughly 0.5 million in the second quarter of 1940.

SPECIFIC ESTIMATES

Such estimates as have been described, however, do little more than indicate the general magnitudes of the problems we face. While they have value in connection with broad policy problems, the detailed planning of training, housing, or production programs requires more specific estimates. Therefore, more than a year ago we undertook to prepare specific estimates of labor requirements for the principal defense industries.

A substantial part of the early defense program was made up of construction projects—cantonments for our expanding army; new facilities for the Army and the Navy; and new industrial facilities for increasing our output of plants, guns, and tanks. The Bureau's accumulation of data on PWA construction projects made possible the prompt preparation of estimates of requirements for construction labor.

Similarly, estimates of the labor required in connection with the production of aircraft and ships were prepared immediately after the first contracts were let, and have been revised with each major expansion of the program. In this case, since large parts of the program were placed under contract very promptly, it was possible to indicate quite accurately not only the total volume of labor required from month to

month, but also its geographic distribution. Studies of the occupational patterns of labor in shipyards and aircraft plants made it possible to go even further and indicate the occupational composition of the increased demand.

For ordnance items such as tanks and guns there were no basic data in the Bureau's files which would indicate the number of men or manhours required. It was necessary therefore to obtain from the manufacturers and the arsenals estimates of the labor they were going to require to complete their contracts.

These specialized estimates cover only the most important segments of the entire program. They do not add up to the total estimates described earlier, nor should they. However, they have served an extremely useful purpose—that of supplying detailed specific data on the critical defense industries.

THE IMPACT OF WAR ON LABOR SUPPLY AND LABOR UTILIZATION*

By Louis Levine
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THE EXPERIENCE of the past 18 months of the defense program with respect to problems of labor supply and utilization of labor will stand us in good stead during the war period. From a decade characterized by huge surpluses of workers willing and able to work but unable to find a job, this Nation has moved into an era in which acute stringencies of labor in many occupations are already widespread. Shortly after the rearmament program got under way, shortages of skilled workers in a number of highly essential occupations required by important defense industries confronted us. The shortages in machine tools and aircraft dated back to the fall of 1939, when the British and French demands came into being. The requirements of our own defense program accentuated the labor supply problems in these industries and quickly brought to our attention the needs in such other industries as shipbuilding and ordnance. The most serious aspect of the labor supply problem is that of obtaining the manpower required for a relatively small number of skilled defense occupations. During the defense period, it was difficult to awaken employer concern regarding effective utilization of labor resources. Furthermore, as the impact of shortages of critical materials and curtailment of civilian production came to the fore, there was a tendency to be less concerned about availability of labor and to give increasing attention to so-called priority unemployment. The tremendous expansion of armament production now required once again brings into the limelight the serious problems of labor supply and efficient utilization of labor.

Modern warfare differs from earlier wars chiefly in the degree of mechanization of the armed services and, therefore, the extent to which skill is required both in civilian and military groups. The production and replacement of aircraft, ships, tanks, and other ordnance requires a higher ratio of skilled workers to total employment than has been necessary in the past. The far-flung theaters of war and the intensity of war operation place a tremendous burden on the civilian population to keep the armed services supplied. The experience of the past 18 months is but a foretaste of the problems which now arise and the recognition of the gravity of these problems recently has resulted in the taking of several important steps. The nationalization of the public employment

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offices into the presently constituted United States Employment Service represents a recognition of the national character of the labor supply problem and provides an important mechanism for the organization of the labor market and the orderly occupational and geographic transfer of workers from civilian to war-time production. The recently enacted legislation for registration of all males between the ages of 18 and 64 is directed toward the mobilization of manpower, not only for military service, but also for civilian production to support the armed service.

It became evident quite early that the problems of labor supply and efficient utilization of labor could not be resolved without current and comprehensive labor market information upon which basic policies could be formulated. In contrast to the situation faced by this country in the last war, we have today an extremely important body of labor market data, and the resources of the local offices of the United States Employment Service bring forth currently from each locality an indication of the supply and the demand for labor as well as the changing characteristics of the labor market. Each month the public employment offices report the number of available qualified workers registered in over 600 of the occupations most essential for the war program. Each 60-day period representatives of the employment offices visit employers in selected war industries employing 50 or more workers to obtain their prospective hiring and lay-off schedules by specific occupations for the ensuing 6-month period. In November, some 12,500 plants employing approximately 5,760,000 workers reported their prospective employment schedules. Each month the public employment offices report for each locality and by industry the important developments in the labor market with respect to changes in hiring practices and specifications, scope of the defense training programs, migration, housing problems, etc. The United States Employment Service, through its 1,500 full-time local offices and 3,000 part-time offices, has become the central source of labor market information for other governmental agencies concerned with labor problems. For example, approximately 300 local labor market surveys have been completed. These surveys intensively analyze the economic characteristics of a labor market area, the current and future demands for labor, the size and composition of the available labor supply, the methods for recruitment of labor not available locally, and the general community problems affecting the labor market. Virtually every important community in the country has been surveyed and some of these have been re-surveyed many times. Such information is extremely important in determining the allocation of defense housing, the awarding of armament contracts,

the location of war plants, and the orientation of training programs. As material shortages and civilian production curtailment began affecting increasingly large numbers of industries, public employment offices obtained information from individual employers affected regarding the number and types of workers laid off or to be laid off in order that such workers might be utilized by other employers for armament production in the event that plant conversion by present employers could not be effected. Where an entire community was threatened with serious unemployment because of the rearmament program, local community surveys were undertaken by the employment offices and in some instances such communities have been certified as distress areas, thus permitting employers in those areas to be given special consideration in the awarding of armament contracts.

Obviously labor market information, important as it is to the formulation of labor supply policy, is only the beginning in meeting the problems of labor supply and utilization of labor. The defense program, and now the war effort, exerts a vital influence upon the size of labor supply, its composition, and its utilization. At all times entrance to and exits from the labor market are extremely important determinants of labor supply. The increased earning power and the large volume of job opportunities have influenced many young persons to enter the labor market. Likewise, retirements from the labor market have been reduced and many workers who had already retired have returned to employment. The character of employer specifications is also an important factor in influencing the labor supply. The increasing shortage of skilled workers has already been reflected in the relaxation of employer specifications with respect to age. There are, however, many restrictive specifications which interfere with fullest utilization of labor supply. Restrictions against the hiring of non-citizen workers prevail in almost all industries, although legal limitations apply only to employment in the aircraft industry and to work on secret contrivances. Similarly, there is widespread evidence of a failure to hire Negro workers. During the third quarter of 1941 the public employment offices made 149,000 placements in some 20 selected defense industries, but only 3 per cent of such placements were of non-white workers. The greatest gains in Negro placements have taken place in the service occupations. There is, however, a tendency slowly emerging to hire Negroes in such occupations as cement finisher, bench molder, and form builder and shaper. Thus far the entrance of women into the labor market has largely taken the form of replacement of men who have left the service and trade industries to enter manufacturing. Only recently has the tendency emerged to hire women as production workers. In aircraft, women

workers are now used to assemble airplane radios and as polishers and aluminum welders. In some industries, increasing numbers of women are being used as spot welders, tracers, solderers, and milling-machine and drill-press operators. There can be no question that the most efficient utilization of our labor will not take place until restrictive specifications unrelated to the occupational qualifications involved are removed.

An important source for augmenting our labor supply lies in our training program. The unfortunate experience of the 10 years preceding the defense program during which apprenticeship and in-plant training activities were discarded is difficult to overcome. Great strides have been made, however, in the expansion of the defense vocational education program. Over 1,775,000 persons were trained during the past year and 50 per cent of such training was in essential occupations. The demand for labor today, however, indicates that employers are frequently in such need of labor that they cannot wait until the completion of training courses. The defense vocational training program does not turn out highly experienced or skilled workers. The training period is short but if workers are to be made available more quickly, training periods will probably be shortened even further. Increasing emphasis will have to be given to in-plant training and perhaps less to preemployment training. As job processes are scrutinized more carefully and as such processes are simplified into their component parts, less-skilled workers will be required. To a considerable extent the shortages in the highly skilled occupations can be met only by upgrading of workers from less-skilled occupations and by transfer of skilled workers from civilian to armament production. We do not now have in our labor supply unemployed skilled workers in the essential armament occupations. The effective utilization of labor requires occupational and worker analysis. The work of the occupational analyst in the United States Employment Service, the availability of the occupational dictionary (covering some 18,000 occupations and prepared by that service) and the increasing awareness of management with respect to the possibilities that lie in occupational analysis, are important factors in augmenting our labor supply.

In normal times the armed forces of our country do not have an appreciable influence upon the labor supply. Even with an Army of a million and a half young men, our labor market was not seriously affected. With a prospect, however, of 4 to 7 million men in our armed services, the problem of labor supply becomes increasingly serious. It is extremely important that the needs of our armed services be met, but it is equally important that the production of supplies for our armed

services not be impaired. For this reason, the selective service process must give increasing attention to the problem of occupational deferment. The final test lies in whether a man will contribute more to the war effort in an armament plant or in the armed services.

There are, of course, many other factors that influence the labor market such as wage rates, hours of work, and adequate housing. These factors I conceive to go beyond the scope of this paper. They are nevertheless important, for they impede our war effort to the extent that they disrupt production, create labor disputes, and cause high labor turnover. There are other factors such as costs of living and rent which also have a bearing on the labor market. To discuss all of these would require more space than limitations permit.

No discussion of labor supply and utilization of labor would be complete without some attention to the problems of distribution of defense contracts by industry and geographic area. Certain sections of the country have been overburdened with armament work to such an extent that serious labor supply problems have emerged and in their wake have come problems of housing, sanitation, schools, etc. On the other hand, there are other areas in the country which have been affected only slightly by contract awards. The concentration of defense contracts in certain areas along the Pacific Coast and in various sections of New England, Middle Atlantic, and Great Lake States has stimulated a vast migration of workers from other parts of the country. The maldistribution of contracts has undoubtedly accentuated the problems of labor supply and dislocation. The strenuous efforts now being made to spread contracts more evenly throughout the country become more important than ever. Sub-contracting must be increased to the point where every plant and facility, no matter what its size, may participate in the war program.

Available data indicate that wide variations exist throughout the country in the distribution of defense contracts for other than construction and the supplies of labor available for employment. The New England States, for example, have approximately 12 per cent of the contracts and defense employment, but only 5 per cent of the active file of persons seeking work through the United States Employment Service; nevertheless, about 8 per cent of the hires defense industries expect to make by May 1942 will take place in New England. Even more strikingly, the Middle Atlantic States have approximately 32 per cent of the contracts and defense employment, and employers in these states anticipate making nearly 30 per cent of the hires in defense industries anticipated by May 1942; these states have only 21 per cent of the active file. The situation in the South and the West is far different. The

Southeast States, for example, have received only 5 per cent of the contracts, have only 3 per cent of current employment in defense industries, and anticipate making about 7 per cent of the defense hires between now and May 1; they have over 12 per cent of the active file. Likewise, the Gulf States have only 4 per cent of the defense contracts, 3 per cent of the current employment and anticipate making only 6 per cent of the new defense hires through May 1; they have about 14 per cent of the active file.

Perhaps the best approach to an analysis of the impact of the war program upon labor supply and utilization of labor is to proceed to a study of specific labor market areas, each of which illustrates a different type of situation in which adjustments in labor supply and utilization of labor became necessary.

Detroit. Detroit at the moment is our most spectacular illustration of the labor market dislocations caused by the outbreak of war. Virtually every problem associated with a shift from peace-time to war production is reflected in this area. From our most important urban center for the production of consumer durable goods, the city, because of the necessity of war, is being transformed into a great arsenal of planes, tanks, and guns.

At the beginning of 1940, the Greater Detroit area had a population of over 1,800,000, of whom about 360,000 were gainfully employed. By the end of 1941, employment had increased 17 per cent to a total of 411,000 workers, of whom about one-third were engaged in defense production. The additional workers employed have been recruited both from the locally available unemployed reserve and from the large numbers of workers migrating to Detroit in response to job opportunities and high wage levels.

The outlook for 1942 forms a rather confused picture. Industry—primarily the automobile industry—affected by drastic curtailment of automobile production, must convert existing facilities and increase defense production at a far more rapid rate. During the transition period, thousands of automobile workers will be thrown out of employment, with little immediate prospect of reemployment on defense work. The estimated number that will be displaced during the early part of 1942 varies between 50,000 and 100,000 workers. Reemployment depends, to a large degree, on the speed with which plants can be converted and on the completion of new facilities. There are, in addition, many complicating factors, such as shortages of certain types of skilled workers and the necessity for large-scale training and retraining of workers in order to fit them for the new jobs. It appears likely that absorption of the displaced automobile workers will proceed rapidly

during the second half of 1942 as the output of planes and tanks grows to large proportions. An actual labor shortage may develop, particularly if displaced workers migrate to other areas in search of employment.

New Orleans. New Orleans illustrates an urban, non-industrial city which almost overnight has become one of our chief producers of direct war tools, such as cargo ships and fast torpedo boats. In 1940 New Orleans, a city of half a million population, was principally a transportation terminal, the major port of the Mississippi Valley and coordinating center for railway, motor trucks, airway, inland waterway, and deep sea steamship services. Of a labor force comprising more than 200,000 workers, only 20,000 were employed in the city's manufacturing industries. Of these, over three-fourths were engaged in food-processing and in the production of textiles and clothing. Shipbuilding and repairs furnished employment for only 4,500 of the community's gainful workers.

By September 1941 the number of workers in manufacturing employments had increased by 45 per cent over the previous year, and were turning out more than 20 different products to fulfill primary defense contracts totalling about 43 million dollars. In addition to the great increase in shipbuilding and ship repair activities, defense contracts have expanded the iron and steel, machine shop, and clothing industries. Increased production has required the expansion of existing facilities as well as the building of new plants and shipways.

Recent estimates put the number of additional workers to be hired by September 1942 at 8,000, nearly all to be employed by the shipbuilding industry. The labor requirements of defense production have been and will probably continue to be met largely by the locally available supply of unemployed workers. In-migration is limited to a few key technical workers.

Philadelphia. Philadelphia is an example of an urban center making products indirectly related to defense needs which has been transformed into one of the Nation's most important defense centers. The city began declining as an industrial center in the early 1920's. By the time the 1929 depression hit the country, the demand for its industrial products was so drastically reduced that the city became one of the Nation's most seriously depressed communities. The 1940 census showed Philadelphia as one of the cities which experienced a decrease in population during the last decade.

But from June 1940 to October 1941 the city has received War and Navy Department contracts, especially for shipbuilding, metal products and textiles, amounting to approximately $1,000,000,000. The

effect of this deluge of war orders became evident everywhere. Idle factory space, which seemed a liability a year and a half ago, is now at a premium. Dismantled shipways and those in disrepair are being rebuilt and reconditioned. At present, machinery, long idle in transportation equipment factories, is making guns, tanks and ammunition. Shipyards are roaring with work on rush orders.

The local supply of labor is far too inadequate to meet demand. Thousands of workers will have to be brought into the area. However, near by are areas of surplus labor such as the coal mining section of eastern Pennsylvania, and the agricultural areas of eastern Pennsylvania, southern New Jersey and Delaware, which can be easily tapped by the city.

Radford-Dublin. What has happened in the Radford-Dublin area of Virginia illustrates the impact of defense upon a rural economy into which a major war plant is suddenly placed. These small towns are the centers of a constantly expanding powder manufacturing and bag-loading plant, respectively. Previously, considerably more than one-third of the 46,000 gainful workers in this labor market area followed agricultural pursuits and only 9,000 workers were engaged in the manufacturing processes.

Within the relatively short space of one year, the communities and their environs were transformed from a primarily agricultural and domestic economy to a refurbished industrial "arsenal for democracy." By December 1941, the number of workers in manufacturing had almost doubled to approximately 17,000, radically changing the industrial composition of the area.

The labor supply available to meet these extraordinary demands was estimated at 10,000, of which half were men formerly employed on the construction of the plants. Most of the available workers were qualified only for unskilled and semiskilled occupations.

Hiring techniques involved on-the-job training, upgrading, and the transfer of key workers from other key plants of the operating company. An outstanding source of supply was the use of women, more than 2,000 of whom were employed at the bag-loading and textile plants alone. Finally, wage rates were sufficiently above those prevailing in the area to enable the management to compete successfully for workers, despite the danger involved in handling powder. Employment of Negroes presented no problem because of the predominantly white character of the population.

The development of the Radford-Dublin area illustrates effective utilization of America's labor supply. The relatively simple productive processes of the two plants permitted the tapping of a large labor pool

without the inevitable dislocations arising from a heavy influx of workers.

A review of our labor supply problems and the utilization of labor as currently evidenced in our war industries indicates that we are not likely to be faced in the very near future with a general labor shortage —that is, a shortage of manpower and womanpower.

However, this conclusion should give rise to no complacency in the formulation of basic labor supply policies. The immediate task of adjusting men to jobs and jobs to men is a formidable one. The transition from civilian to war production has not yet been made and many serious problems involving geographical and occupational transfers lie immediately ahead. We cannot afford to tolerate the labor market malpractices now emerging, such as labor scouting and piracy, unrestricted advertising, and competitive dislocations. Neither can we afford the aimless migration of large numbers of workers in response to often ill-founded rumors of job opportunities. The responsibility of the Government with respect to organization of the labor market is greater now than ever before. Only through the formulation of labor supply policy by Government, closely geared to the schedule of armament production and to the changing needs of military operations, can our war effort be brought to a successful termination. The challenge is great, but the resources of Government, management, and labor in this country are equal to the task.

ON CERTAIN BIASES IN SAMPLES OF HUMAN POPULATIONS*

By Jerome Cornfield
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HISTORICALLY, samples are an outgrowth of case studies, not of the mathematical theory of sampling. The case study derived conclusions on the nature of a parent population on the basis of the characteristics of a single individual. The sample was originally a collection of case studies. Thus in the field of family expenditure studies one of the pioneer works was LePlay's six volume work, *European Workers*, based upon an intensive study of the incomes, expenditures and savings of 36 families. It would not be unfair to say that up to the present day European studies of family expenditures have been extensions of the technique developed by LePlay rather than applications of the mathematical theory of sampling.

Now the data yielded by mere collections of cases are not without value; they may give the investigator greater insight into his subject; they may strengthen his intuitive grasp; they may possess a high order of intrinsic interest. The one characteristic they lack, however, is the ability to provide statements of a known order of accuracy about a parent population.

The best known example of a collection of cases which was completely incapable of performing the function of a sample, providing an estimate of the value of a population parameter, is, of course, the 1936 *Literary Digest* poll. In the issue immediately after the election returns had been received the *Digest* commented:

> Other statisticians took our figures and so weighted, compensated, balanced, adjusted and interpreted them that they showed Roosevelt. We did not attempt to interpret the figures, because we had no stake in the result other than to wish to preserve our well-earned reputation for scrupulous bookkeeping.

The lesson of the *Digest* poll is less, I think, the fact that telephone directories and automobile registrations will not furnish an unbiased estimate, no matter what the size of the sample, than that a sample is not a matter of scrupulous bookkeeping. As a matter of fact, it was possible to take the published *Digest* results and estimate a Roosevelt majority. The poll showed that 52 per cent of the persons returning ballots in 1936 who also reported their 1932 vote had voted for Hoover in 1932, whereas Hoover had actually received 41 per cent of the 1932

* A paper presented at the 103rd Annual Meeting of the American Statistical Association, New York, December 28, 1941.

vote. By reweighting in such a fashion as to assume that the poll was correct in showing the way in which 1932 Hoover and Roosevelt voters would vote in 1936, but incorrect in showing the relative proportion of Hoover and Roosevelt voters in 1932, an approximately even split in the vote between the two major candidates was indicated. Since this was the most favorable assumption that could have been made in view of the *Digest's* sampling procedure, a Roosevelt majority was clearly indicated. At least as important a source of the *Digest's* error as the selection of the sample therefore was its failure to go beyond matters of scrupulous bookkeeping.

A sample of families obtained by drawing names from a payroll listing earners may be something worse than a collection of cases, if the data obtained from them are not suitably handled. It may not be entirely obvious that such a procedure has a serious bias. The chance of a family being included in the sample becomes dependent upon the number of earners it has; the greater the number of earners the greater the chance of its being included. Since families with several earners generally have higher incomes, more adult members, and fewer children, this sampling procedure would result in definitely biased estimates, had the sample been regarded merely as a collection of cases. A sample drawn on this basis may be used to produce valid results, however, if it is properly weighted. This problem came up in connection with the Bureau of Labor Statistics' study of the family expenditures of wage earners and clerical workers.

If p per cent of all workers are included in the payroll sample, then it is easy to see that the probability of a family with i earners being included in the sample is $(1-q^i)$, where $q=1-p$. If there are N_i families with i earners in the parent population, the expected number of families with i earners given by payroll sampling is $(1-q^i)N_i$, whereas the number given by an unbiased procedure would be pN_i. The procedure devised by the Bureau to counteract this, in effect, involved grouping families by the number of earners and assigning to each group a weight. The weight for the ith group is $p/(1-q^i)$. For a sufficiently small p this expression reduces to $1/i$, the weighting factor that would intuitively occur to one.

An alternative method of handling the problem, of course, is to include the family in the sample, only if the sampled earner is the chief earner, or more generally has any characteristic which only one earner in the family can have. This same problem arises, of course, in the selection of a sample of families from census enumeration sheets listing each member of the family. It has also occurred in drawing a sample of law firms from a directory of lawyers.

There are probably two important obstacles to drawing samples from finite populations which can be used to make predictions. First of all, to draw such a sample we require what amounts to a complete listing of the units in the parent population. If there is no complete listing, there is no possibility of devising a sampling procedure which gives each possible sample the same chance of being drawn. And, if this condition is not satisfied, the order of accuracy of any inference about the parent population is unknown.

Many expedients have been used to derive such lists but it is doubtful whether any of them has been entirely successful. The city directory has been widely used to draw a sample of households and yet a sample count of the households listed in the 1941 Washington City Directory indicates that it contains 25 per cent fewer households than the Census enumerated in April 1940.

When a sample of individuals or households is taken it is usually possible to dispense with a complete listing of the parent population by taking a sample of areas, when a complete list of the areas within which that population is located is available. After that, one can either enumerate all individuals living within the sampled areas, the procedure usually followed when simple schedule forms are used, or alternatively prepare lists of all persons living in the sampled areas and sub-sample from these lists. The latter is the procedure employed by the Works Progress Administration in its labor market studies.

When the parent population being sampled is relatively small, however, but dispersed over a large area, the cost of areal sampling may be well-nigh prohibitive. Such is the case when a sample of industrial establishments, particularly within a single industry, is taken. The absence of a listing of the parent population in such a case may be illustrated by the sample involved in indexes of employment for industries with a large number of small establishments. Changes in employment are a result of two factors: changes in the average number of employees per plant and changes in the number of plants. To estimate the first factor it would be sufficient to draw a single sample of plants and compute the number of employees in them in successive months. To estimate the second with any precision, however, it would be necessary to draw a new sample of plants every period. To do this, however, would require a new directory of plants in each industry every month. As a result, estimates of changes in employment in many industries are essentially estimates of the first factor only. Over a period of several years, in particular, such estimates frequently develop a marked cumulative error. To correct this it is necessary to adjust the estimates to the results of the biennial Census of Manufactures after making certain

that the industrial classifications are identical. Given the present state of industrial directories, it is doubtful if anything more could be done to improve the estimates, at least on a sample basis.

A second serious source of error in field surveys is the refusal rate. Human populations differ from balls in an urn at least to the extent that the balls cannot object to being included in the sample. The most usual, but certainly not the only case, in which such refusals occur is in the survey conducted by mailed questionnaire. Frequently the questionnaires are mailed to a substantial part of the parent population and whatever fraction of the original questionnaires are returned are tabulated, and the results published as a sample.

A minimum requirement for such surveys is to compare some characteristics of the parent population with the characteristics shown on the returned questionnaires. In a recent survey of the housing conditions of federal employees, for example, the necessity for prompt release of results dictated the use of questionnaires distributed directly to a sample of federal employees at their desks. It was possible to predict at least one result in advance. Employees on leave or in the field would not return questionnaires. The amount of bias that could be introduced by this factor alone was unknown. To obtain some indication of it the sample of employees was drawn from Treasury payrolls and both the name and the monthly earnings of each employee so sampled were recorded. The income distribution shown by the returned questionnaires was compared with the distribution given by the sampling from the Treasury payrolls. The amount of bias, at least with respect to income, was comparatively small. Roughly 75 per cent of all questionnaires distributed had been returned, with slightly more than 75 per cent at the lower income levels and 61 or 62 per cent at the two highest. The possibility of substantial biases with respect to other factors still existed, however. This relatively small differential refusal rate is probably unusual for questionnaires. It is at least partially explained by the fact that the questionnaires were distributed by the administrative officers of the various agencies, and were filled out in office time. More frequently, when such an analysis discloses biases, or more precisely differential refusal rates with respect to different factors, it is necessary to weight the sample by small categories or strata to compensate for the refusals. More generally, attention is now being given to the possibility of an actual field interview of a sample of the non-replying persons. This technique, if properly handled, may give unbiased estimates while retaining much of the economy of a mailed questionnaire.

Even in field interviews, as distinguished from mail surveys, the refusal rate may seriously bias the returns. First of all, sampled persons

may not be at home at the time of the agent's visit. More frequently, however, there is a minority of the population that may refuse to give any information. The Consumer Purchases Study, for example, had been sufficiently identified in the minds of many people with the New Deal for a substantial refusal rate in the upper income groups to appear. Despite the attempt to substitute families of the same economic status for the refusing families, this bias was still marked. Thus out of 178,000 income tax returns filed in Chicago, almost 10,000 were for incomes of $7,500 or more, whereas the estimate of the number of Chicago families with incomes of this amount made on the basis of the Consumer Purchases Study sample was less than 4,000. This discrepancy is, of course, too large to be explained by sampling error. In preparing estimates of the income distribution of all families in the country on the basis of the Consumer Purchases Study, the National Resources Committee found it necessary to supplement the sample data by the information afforded by income tax returns.

In some cases the refusal rate may be definitely affected by the type of schedule used. In collecting data on family expenditures, for example, there have been two generally accepted methods. One has been to send an agent to each sampled family and ask a responsible family member to recall in detail the family expenditures during some period preceding the agent's visit. The other has been to ask each sampled family to keep a detailed statement of its expenditures as they are made. The merits of the methods have been discussed pro and con for some time, with the first method in general use in this country and the second in general use in Europe.

In its 1934–36 survey of the family expenditures of wage earners and clerical workers, the Bureau of Labor Statistics experimented with both methods. The bulk of its data was collected by means of a schedule which relied upon the housewife's memory. Partly for the purpose of checking on the accuracy of these reports a certain per cent of the families were revisited and asked to keep detailed records of their food purchases and consumption. All food in the larder at the time of the agent's first visit was weighed, the housewife was furnished with a set of scales to weigh all purchases, and the food on hand was weighed again at the end of the reporting period.

Now it is apparent that families willing to undergo such an experience may not be completely representative of all families. A comparison of the families who kept these detailed records with the families who gave schedules based upon memory but did not keep detailed records discloses several characteristic differences between the two groups. Out of the approximately 1,500 families in the 4 cities included

in this experiment, about 300 kept records of their food consumption for one week, 1,200 did not. Of those keeping records 10 per cent had home makers employed outside the home; of those not keeping records, 20 per cent had employed home makers. One of these research methods thus had the effect of causing a much higher refusal rate among families with employed home makers than the other. Significantly different refusal rates were also discovered with respect to type of family. Families consisting of husband and wife only, and families lacking at least one spouse kept records much less frequently than families with husband, wife and other members.

Perhaps an even more interesting consequence of keeping records is the actual effect of the keeping of the record upon the consumption of the family. The purpose of recording food on hand at the beginning and end of the reporting period was to obtain an accurate measure of consumption, as distinguished from purchase. On computing the value of inventory change, however, we discovered that virtually all the families had less food on hand at the end of the reporting period than at the beginning. This tendency was observed in every city studied and for virtually every food analyzed. Apparently to avoid weighing each purchase almost all the housewives had discovered the expedient of consuming as much as possible from their larders. Estimates of the food purchases of families were consequently biased downward. In fact a comparison of the purchases of the same families as shown on the schedules which relied upon memory, and records kept for a period not more than 30 days distant from the period to which the schedules referred, showed that total value of purchases was significantly lower when records were kept than when memory was relied upon, while the value of food consumed was significantly higher.[1]

Examples of bias in field surveys can be multiplied indefinitely. In general, we may say that the possibilities of bias are always present in even the most well-conducted of surveys and are frequently beyond control. Consequently they must always be explored and the possible necessity of weighting to reduce the resulting bias constantly kept in mind.

[1] A more complete analysis of this experiment is now being prepared.

DEFENSE MIGRATION AND LABOR SUPPLY*

By Howard B. Myers
Work Projects Administration

For the second time in a decade migration is front page news. Again feature writers are presenting the life histories of migrant workers and their families, camera men are busily photographing the "typical migrant," newspapers and popular magazines are describing the frenzied conditions in destination towns. Again the Nation is hearing the story of "America on the move."

There are important differences, however, between the migration of the early thirties and the present movement. This is boom, not depression migration. Whereas in the thirties migration was stimulated by sharp employment declines, now it is stimulated by equally sharp employment gains. Whereas in the thirties most migrants were poverty-stricken, unsuccessful in their search for steady work that would yield a decent income, most migrants today appear to be finding jobs at relatively high wages. Whereas in the thirties migration was largely negative—an attempt to escape from known misery—present migration is largely positive—a move with the expectation of steadier employment, better wages, or the acquisition of a higher skill. And, whereas in the thirties, migration was viewed with serious concern by the public, today it is received with general public approval.

In a broader sense, of course, the stimulus of both defense and depression migration is the same. The drive that caused the large scale westward movements of the 19th century is still operating. From the point of view of the migrant, migration is an expedient resorted to in an effort to improve his economic status. In most cases he moves in the hope of finding employment, getting a better job, or obtaining higher wages.

The difference in public reaction to present-day migration results from the fact that, after 10 years of large-scale unemployment, the Nation is suddenly experiencing a boom market for labor. Unemployment is still large, but it is assuming less formidable proportions. Faced by a sharply growing demand for workers in war industries and by large-scale withdrawals to the armed forces, many persons are already prophesying that we shall soon face a general shortage of labor.

Fortunately the labor supply is extremely flexible. As the need for labor grows, the number of workers offering their services in the market will also increase. Nothing approaching a *general* labor shortage is likely in the foreseeable future.

* A paper presented at the 103rd Annual Meeting of the American Statistical Association in joint session with the American Association for Labor Legislation, New York, December 29, 1941.

Expanded war production has, however, created real shortages of workers of certain types and skills. These shortages are frequently acute in areas of rapid industrial growth. The specialized and concentrated demands of modern war have thus turned attention to ways of increasing the effective supply of labor in areas of defense concentration.

Broadly speaking, factories swamped with war orders can draw from four sources of labor supply.

First, from the existing supply of unemployed workers in the area. Even the most active defense centers have their unemployed—workers who, although clearly employable, cannot qualify for the available jobs because of age, sex, race or lack of needed skills. Many of these workers will eventually get jobs as the demand increases and hiring standards are further relaxed.

Second, through the transfer of workers presently engaged in other pursuits within the area. This process is stimulated by the higher earnings in war industries; reports indicate that considerable numbers of self-employed workers and workers in various service industries are already shifting to defense jobs. The transfer process is also hastened by employment reductions in non-defense industries resulting from the curtailment of essential materials—the so-called priorities unemployment.

Third, from non-worker groups among the resident population who are induced to enter the labor market by the prospect of easily-secured jobs at high wages. The number of persons who may decide to become workers during a war-time boom is very large—for the country as a whole it runs into the millions. Recent studies show that non-workers have already entered the market in large numbers in many centers of defense activity, and it may be expected that the declaration of war will accelerate this movement.

Fourth, from the supply of migrant workers attracted to the area by reports that jobs are plentiful and that good wages are being paid. In many areas the available and potential local labor supply appears ample to meet all prospective needs. In other areas, however—notably the sites of large construction jobs and a number of very rapidly expanding shipbuilding and industrial towns—the resident supply of labor is clearly inadequate.

The sharp concentration of defense contract awards is altering our previous industrial pattern, thus necessitating the migration of labor on a considerable scale. The accelerating impact of priorities unemployment, superimposed upon existing unemployment, is creating rather formidable labor surpluses in many areas, thus developing an expulsive force which adds to the total volume of movement.

The result has been a sharp stimulation of movement to many areas of the country. This defense migration has been brought vividly to public attention by the rapid massing of large numbers of construction workers in isolated army camp and powder plant towns.

The needs of war have thus transformed the migrant "bum" of the depression to the respected war worker of today. The border patrols and restrictive legislation of a few years ago are being replaced by a variety of devices to encourage migration, including advertising by private contractors, expansion of the public employment office clearance system, and the defense housing and community facility programs. Poor housing, overcrowding, health hazards, skyrocketing rents and inadequate school, sewer and water systems are now matters of public concern, partly because it is feared that such undesirable conditions may discourage the migration of needed workers.

It is clear that defense migration is raising increasingly serious problems. As in the case of depression migration, however, there is a general lack of knowledge concerning the development. Little definite information is available as to the extent of the movement, its success, or the types of persons moving. Once again imagination has been substituted for research. The wild tales of the thirties, which had hundreds of thousands of half-wild boys and girls roaming the country, are now replaced by equally exaggerated reports that all America is on the march.

In an endeavor to substitute fact for fiction, the Federal Security Agency some months ago requested that the WPA Division of Research undertake a series of studies of migration to defense areas. The surveys were designed primarily to determine how many workers and persons had moved to the area during the past year, where they had come from, what types of people they were, the occupations and industries in which they had been employed, the success of various groups of migrants in finding employment after migration and the extent to which they had shifted to new occupations and industries after migrating. The surveys covered the activities of civilian workers only, and no attempt was made to gather information about persons who had left the survey city during the year.

The information was secured through a sample census of each area, using techniques generally similar to those of the WPA Monthly Report of Unemployment.[1] Particular attention was given to coverage of rooming houses, lower-priced hotels, defense housing projects, and tourist and trailer camps.

In all, 51 areas were selected for survey. Most of the cities selected

[1] See "Dynamics of Labor Supply," by Howard B. Myers, this JOURNAL, Vol. 36, pp. 175–184, June, 1941.

had received large war material orders or construction contracts; a number of towns with few defense contracts were included as control areas. Data are now available for 40 cities and surveys are in process in the remaining 11 cities. The results of the survey are presented in a brief mimeographed report for each city.

The data thus far available appear to warrant a number of observations concerning defense migration, pre-war phase. It should be said at the outset that generalization concerning the movement is hazardous. The situation varies markedly by locality, depending on such factors as the type and intensity of defense activity, the size of the resident labor supply, the economic situation in nearby areas, and the ability of the community to house and service the incoming population.

Before going further, I should point out that by no means all migration to defense areas is defense migration in the narrow sense. Broadly speaking, one non-defense worker moves to a defense town for every worker who comes in to take defense employment. The enticing prospect of a job draws clerical and service workers as well as skilled metal tradesmen, operatives and construction workers. Many of these workers secure jobs which contribute indirectly to the war effort, others join the ranks of the resident unemployed. All contribute, however, to the social and economic problems which migration raises and, consequently all are included in the discussion which follows.

In general, defense migration has been of two main types: (1) the movement of construction workers to camp and new facility sites, many of which have been located in rural or small-town areas; (2) the movement of workers to war industry centers, for the most part the larger cities. The industrial movement has been less spectacular, but is of longer duration and socially and economically is much more important. I shall discuss primarily this latter type.

Perhaps the primary point to make concerning defense migration to date is that, by and large, it has been a good deal smaller than many of the more frenzied newspaper and magazine stories would have us believe. The movement to large construction jobs has been impressive, of course, but most of this has been temporary. It is true, further, that a few industrial towns have experienced a hectic mushroom growth. Migrants into San Diego, California, total 27 per cent of the 1940 population—the highest rate among the 40 areas for which figures are now available. Wichita, Kansas, a booming aircraft center, is second, with a 20 per cent migration rate. While the rate of migration is lower, some of the larger cities have experienced truly astounding in-movements. For example, more than 150,000 persons have moved into Los Angeles and its satellite towns since October 1940. Since the same date more than

50,000 persons have moved into Washington, D. C., and more than 40,000 to Seattle, Washington.

These cases are exceptional, however. In more than half of the 40 areas for which data are available the migration rate has been less than 5 per cent, and in only 9 of the 40 cities has it been 10 per cent or more.

On the other hand, the surveys indicate that the rate of migration has been increasing in most areas. It is probable that it will grow even more rapidly during the coming months, stimulated by the marked intensification of the war effort, by the near-absorption of the resident labor supply in certain "hot" areas, and by rapidly-growing priorities unemployment. During the first year of war, migration should exceed by a considerable margin the volume during the pre-war period.

Second, it is pleasing to report that defense migration thus far has been, on the whole, strikingly successful. In half of the areas surveyed the unemployment rate for all migrant workers is less than 8 per cent; in a fourth of the areas it is less than 5 per cent. Only one city out of seven has a migrant unemployment rate of 15 per cent or more. The highest rate among all cities recently surveyed is 17 per cent, for Fort Smith, Arkansas, where large numbers of workers had flocked in in anticipation of the start of work on a new army camp. Among the very large cities, St. Louis and Los Angeles are highest, each with an unemployment rate of 16 per cent.

In view of the almost completely unguided nature of the movement, and considering the fact that the surveys included considerable numbers of migrants who had very recently arrived in the area and had had little opportunity to adjust themselves, the unemployment rates reported are surprisingly low. Defense migration thus presents a welcome contrast to the tragic experiences of migrants during the depression.

Not only have the great majority of the defense migrants obtained jobs, large numbers of them have got better jobs than they held before migrating. Occupational upgrading has been widespread. Shifts among manual workers from unskilled to semi-skilled, and from semi-skilled to skilled have been especially frequent. As a result of this process the proportion of migrants working at unskilled occupations is surprisingly small—in the great majority of towns less than 10 per cent. Income data were not obtained, but in view of the occupational upgrading reported and the relatively high wages and full employment in most defense lines, it seems clear that the incomes of a large proportion of the migrants have risen.

Although migrants in general have been quite successful in finding jobs, certain groups have fared less well than others. Women have been far less successful than men in obtaining jobs—in most areas their rate

of unemployment is 3 or more times that for men. Negroes, too, have been relatively unsuccessful as migrants—their unemployment rate is 3 or more times the rate for whites in most areas to which Negroes have migrated in appreciable numbers.

Young workers have been generally more successful than their elders. The very young group is a striking exception. In nearly every area workers under 20 reported the highest unemployment rate of any age group. Most of these youth have, of course, entered the labor market recently, and have had little or no previous work experience.

As would be expected the migrants who have been in the area longest tend to have the lowest unemployment rates. In general, migrants who have come from nearby areas tend to report less unemployment than those who have travelled far, probably because the former group more often return home if they fail to get a job.

In nearly all areas skilled manual workers and professional and technical workers have the lowest unemployment rates among the migrants. The least successful occupational groups are nearly always the service workers, particularly domestics, who often report extremely high rates of unemployment.

Negroes make up only a small proportion of the migrants to defense centers. In most areas fewer than 5 per cent of the migrants are Negroes, and even in the South, migration rates for Negroes are much lower than for whites. This is understandable, in view of the widespread discrimination against Negroes in war industries. It contrasts sharply with experience in the first World War, however, when a large scale migration of Negroes to Northern industrial centers took place. As the demand for labor increases and present employment restrictions are relaxed, it is probable that Negroes will begin to move in greater numbers.

Contrary to popular impression, relatively few of the migrants are coming from agriculture. This is rather surprising in view of our large agricultural labor reserve. In most defense centers, however, fewer than 10 per cent of the migrants are farm workers. Even in the South, the proportion is seldom as high as 15 per cent.

Defense centers thus far have secured their workers primarily from urban areas. Most of the rural migrants have come from villages; the proportion from the open country is very small.

Few of the migrants have travelled far; in most centers the average distance is less than 125 miles. The California cities are outstanding exceptions to the general rule. Migrants to Long Beach have moved an average of more than 1,000 miles, while Los Angeles migrants have

averaged nearly 1,300 miles. Workers from mid-Western cities make up a large proportion of these long distance migrants.

Migrants as a group, are young. In nearly half of the cities the average age of all migrant workers is less than 30 years; in no city does the average rise as high as 35 years. The figures reflect both the greater mobility of young workers and the low hiring age limits in many defense industries. In the aircraft town of Wichita, Kansas, where hiring restrictions are unusually severe, the average age of all migrant workers is under 25 years.

The migration surveys provide evidence that the rising demand for labor in defense centers is drawing non-workers into the labor market in considerable numbers. In most of the cities surveyed from 10 to 20 per cent of the migrant workers had never had a job at their previous residence. Most of these persons were students and housewives entering the labor market for the first time. The employment record of this group is generally poor; in most cities the proportion who have obtained jobs is definitely smaller than for migrants with work experience.

The proportion of one-person families among the migrants at their new locations is extremely high, ranging from 30 to 50 per cent for most areas and reaching a peak of 78 per cent for Washington, D. C. It is well known, of course, that single persons are highly mobile. Large numbers of these one-person families are incomplete, however; in most towns the proportion is between 20 and 50 per cent of all one-person families. In other words, from a fifth to a half of these workers left their families behind when they migrated. In part this separation reflects the normal instability of the migration process—the bread winner leaving his family behind until he settles in a new location. In part, however, it results from the serious housing shortages existing in many defense areas.

A striking relationship between the proportion of migrant families which are incomplete and the availability of housing is afforded by a comparison of the migration data with the findings of a series of residential vacancy surveys recently conducted in many of the same areas by the WPA Division of Research. As the residential vacancy rate declines the proportion of migrant families which are incomplete rises sharply. It is clear that many migrants leave their families behind simply because they are unable to find housing accommodations for them. Inadequate housing thus increases the proportion of migrants who are unstable and, in consequence, tends to increase the labor turnover rate in war industries.

The extent of "doubling up" among multi-person families provides a

further index of the congested housing conditions in defense areas. Doubling up is common in all of the defense areas surveyed; in most areas 30 per cent or more of the migrant multi-person families are sharing their dwelling with other persons.

While the extent of defense migration thus far has frequently been exaggerated, the WPA surveys show conclusively that considerable population movements have already taken place and that migration is still on the upswing. An all-out war effort, accompanied by rapid shifts in industrial concentration, vast new demands for labor in some areas and large scale priorities unemployment in other areas, is certain to provide a marked stimulus to the further movement of population.

We are clearly in for large scale migration of labor during the next few years. In many respects this migration may differ from that experienced to date. It appears probable, for example, that as the demand for labor grows migration from rural areas will increase, the movement of women and Negroes will also grow, and these groups will be more successful than heretofore in obtaining jobs.

Migration is already creating serious economic and social problems in many defense communities. It is important that these be solved and that they be solved quickly.

Meantime we should not forget the post-war migrant problems now being created. It seems probable that many war industries will shrink as rapidly as they have arisen, that the present extreme concentration of industrial activity will be to some extent reduced, and that the country will again face large-scale unemployment. These changes will provide new stimuli to migration. The course of post-war migration, however, will be far less happy than that of the present day. Post-war migration may well be depression migration all over again—the type with which we have become all too familiar during the decade just ended.

As the various expedients of the depression years abundantly illustrate, the wise direction of large-scale population movements is an extremely difficult task. To keep suffering to a minimum and to avoid the stagnation of pools of unused labor in new depressed areas requires careful planning over a considerable period of time. Whether such planning will be undertaken on a scale adequate to the problem remains to be seen.

ON THE SAMPLE SURVEY OF UNEMPLOYMENT*

By Lester R. Frankel and J. Stevens Stock
Work Projects Administration

In December 1939 the Division of Research of the Work Projects Administration put into operation a regular monthly survey of unemployment to provide accurate measurements of unemployment, employment and the labor force. Estimates are obtained directly through actual field counts of a cross-section sample of the total population each month. The superiority of this method rises from the fact that unemployment is measured directly rather than estimated indirectly as is necessary in the method used in other periodic unemployment estimates. No additions or subtractions, based upon assumptions as to unemployment reported in the 1930 or 1940 censuses, net average increase in the labor force, or changing age structure are necessary when direct measurement is made. The result of the sampling and direct interview procedure is an extremely fast and sensitive report on the state of the labor market as of one week each month. In some respects the procedures followed are similar to those of public opinion polls.

The Monthly Report of Unemployment operates in a national sample of 64 counties located in 45 states. Within each of these 64 counties a sample of households is selected for interview. These households are enumerated from four to six months in succession and then the sample households are changed so as not to arouse irritation through too prolonged inquiry.

The questions asked provide information on the size of the household, the number of persons under and over 14 years of age, and, for all persons 14 years and older, their relationship to the labor market during the census week, that is, the entire week immediately preceding the week of interview. Each person is asked one or more simple questions to determine whether he or she was employed, unemployed or out of the labor market. In addition to figures on the volume of unemployment and employment, data are secured on the age, sex, duration of unemployment for the unemployed, industry of the employed, and other characteristics of workers and non-workers in the population.

Beginning with the first day of the enumeration week, field schedules are tallied daily in each county. At the close of the enumeration week, a summary of the salient facts is mailed directly to the Washington office for consolidation and interpretation. These summary figures are released in memorandum form usually before the close of each month;

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an average of two weeks elapses between the first interview in the field and the completed memorandum.

After completing the preliminary field tallies, each county supervisor mails the completed schedules to a central machine tabulating office where additional information is taken from the schedules. These additional facts provide the basis for a much more detailed analysis.

In designing the sample, administrative conditions as to time, cost and centralized technical control were kept in mind. To meet these limitations the methods of stratified sampling and subsampling were adopted, involving selection of a relatively small number of primary sampling units (counties) and a subsample of secondary sampling units (households) within each of the larger units. To insure maximum statistical efficiency, both the primary and secondary sampling units were selected on the basis of a stratified sample.

The county was chosen as the primary sampling unit because of the following considerations: The county was a small self-contained geographic unit for which it was possible to obtain statistical information that could be used for stratification purposes. The variance of the unemployment rate between counties was low. Excellent county maps were available that made the county a very satisfactory unit from which to subsample. Finally, administrative operations in the average size county could be handled easily by a local supervisor with six or seven enumerators.

Both administrative and statistical conditions were taken account of in the selection of the secondary sampling unit. The household was chosen mainly because it was the smallest unit that could be sampled readily within a county. Such units were easily defined and located, whereas it would have been practically impossible to select a random sample of individuals without first having listed all persons within the county. The household was desirable also because of certain statistical reasons. A great deal of valuable household data, such as size, number of workers, and employment status, could be obtained only by enumerating household units. Moreover, for a great many characteristics, the household is a more efficient sampling unit than the individual because of the heterogeneity of individuals within households.

All of the counties in the United States were stratified by (1) size, (2) location, and (3) economic situation. Because of the great difference in county characteristics associated with population size, counties were first divided into the following strata:

(1) The nine counties in which the five largest cities are located (containing 14 per cent of the United States population).

(2) The 447 counties with 1930 populations of 45,000 and over (con-

taining 50 per cent of the United States population). These counties are referred to herein as "urban" counties.

(3) The 2,641 counties with 1930 populations of less than 45,000 population (containing 36 per cent of the United States population). These counties are referred to herein as "rural" counties.

Because of the great heterogeneity among the five largest cities, no attempt was made to select a sample of these nine counties; all were included in the sample. Samples of counties were selected from each of the other two strata. The method of selection was the same for both the "urban" and "rural" counties and, therefore, the procedure will be explained in terms of the urban counties only.

All urban counties were further classified by population size into three substrata (terciles): small, medium, and large. The same counties were then cross-stratified by states into three broad geographic locations: Northeast, Southeast, and West, so that there was about an equal number of counties within each of these locations.

The percentage of persons unemployed in each of these counties according to the 1937 Census of Unemployment was used as the third mode of stratification. At that time these data were the most current and reliable which were available for all of the counties in the United States. The counties were then divided into three strata (terciles) according to economic situation.

The urban counties were stratified into 27 cells: three population size groups, by three geographic locations, and by three economic levels. One county was selected from each of 26 of these cells, and two counties selected from the 27th cell because of the relatively high proportion of total urban population in this cell. Within the 27 cells, the selection of counties was at random except that a deliberate effort was made to maximize state coverage.

Twenty-seven counties were selected from the rural counties in a similar manner, using the same modes of stratification.

In all, 64 counties were selected for the sample—9 metropolitan counties, 28 urban counties, and 27 rural counties.

The household sample within counties was stratified according to population distribution. In each sample county the number of households selected within each city, town, village, or other minor civil division was proportionate to the population in those places.

The procedure for selecting the household sample was dependent upon whether the unit fell in an urban place (city, town, or village) or in the open country. In the former, a sample of city blocks was chosen by numbering a map and selecting every nth block; all dwelling units in these blocks were then listed and a subsample of households was

selected from these block lists. The sampling ratio was fixed so that there was an average of no more than 3 households selected per block.

In open country areas the household sample was allocated among the townships or similar minor civil divisions in multiples of 5. In each township one mile sections were chosen at random in the Washington office from maps of the sample counties. Five households are interviewed in each of these sections. The order of selection of households was determined arbitrarily by starting at the southwest corner of the section and proceeding around the section in a counterclockwise direction. Alternate sections were indicated for each township to be used when the original sections did not yield five households. The sections were numbered consecutively at random over the entire county and the enumerator proceeds from the lowest numbered section to the next higher in a township, interviewing up to 5 households per section until the quota for the township is obtained.

The intracounty sample is changed every four to six months. This is a compromise between having a constant group of households to study monthly changes, and having new households to keep the sample dynamic and to overcome interviewee resistance. It excludes persons in institutions and the armed forces.

National estimates of labor force, employment, and unemployment are made by expressing these characteristics in each sample county as a percentage of the total population interviewed, and then proceeding to a weighted average of these percentages for the country as a whole. The weights are proportionate to the populations of the cell or segment of the universe each county is chosen to represent. Thus, the weight of each of the nine metropolitan counties is proportionate to the total population of each of those counties. The weight applied to percentages derived from a county in any urban or rural cell is proportionate to the total population of all counties in that particular cell.[1]

Thus, national estimates are obtained directly in terms of percentages of total population. The total population in this case is defined as all persons not in the armed forces or in institutions.

In presenting labor market data from this survey, the results in percentage form are converted from total population to the population 14 years of age and over. Estimates of national totals are presented in monthly memoranda in absolute as well as percentage form.

[1] By the modes and levels of stratification outlined above, it is possible to obtain national estimates with as few as 27 countries. This may be done by selecting the 9 metropolitan counties, 9 urban counties and 9 rural counties. Both the urban and rural counties must be selected in each case in the form of a Latin square. From information obtained from the 9 urban counties, for example, it is possible to provide estimates for each of the 27 urban cells. Estimates for the urban and rural cells, and metropolitan counties would then be averaged together in the manner described above.

PROPOSED ANNUAL SAMPLE CENSUS OF POPULATION*

By Philip M. Hauser
Bureau of the Census

The impact of World War II on this Nation, necessitating in rapid succession the national defense, lend-lease, and victory programs, has created an urgent need for social and economic statistics. It is fortunate that the Sixteenth Decennial Census was taken and is being completed during this period of national emergency. As a result we are able to mobilize our human and material resources on a sounder foundation of facts than has ever been possible before in a similar period.

Great economic and social changes, evidenced by large population shifts and industrial and occupational dislocations, have occurred, however, with a suddenness which defies the usual statistical description. The nearly two years which have elapsed since April 1, 1940 (the date of the census), are unparalleled in our history with respect to the velocity and extent of change which has occurred. In many communities the changes that have taken place in the number and composition of the population, in the employment status and industrial and occupational composition of the labor force, and in the use of and demand for housing have been greater since April 1, 1940, than in the entire preceding decade. As a result, there is an urgent need for current data, tied to the Sixteenth Decennial Census base, for administrative, legislative, industrial, and scientific purposes.

The Need for Current Statistics. The Bureau of the Census has, logically enough, been the center of a deluge of inquiries for current economic and social statistics from national defense agencies, regular government agencies, industry, business, scientific bodies, and the public at large.

For example, there has been considerable demand for postcensal population estimates for the states and cities—estimates which cannot be made through the usual techniques because of the volume and character of recent internal migration. Such statistics have a wide variety of uses, manifested in the requests for the data which have been received. The Vital Statistics Division of the Bureau of the Census itself, as well as the United States Public Health Service and state and local public health offices, are in need of population figures as a basis for computing current fertility, mortality, and morbidity rates. State and local governments and planning commissions require current population figures for

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the efficient administration and planning of public services. Postcensal population figures are needed by a number of agencies as the basis for the allocation of funds, as, for example, the allocation of funds by the Social Security Board to the states for public health work. Finally, numerous requests also have been received for current population statistics from industrial and business concerns and advertising agencies which are faced with the problem of making adjustments not only to new production needs and priority regulations, but also to rapidly changing markets.

An even more pressing demand for postcensal population figures is found among the defense and war agencies. The large and unknown population shifts affect plans of the War and Navy Departments, the Office of Civilian Defense, and the War Production Board. The aircraft carrier and the airplane have made large sections of our coasts vulnerable to attack, and the adequate protection and mobilization of these vital target areas are facilitated by a knowledge of their population aggregations and composition.

There is need also for current data relating to the labor force. The 1940 population statistics relating to labor were designed largely to measure the volume of unemployment and the characteristics of the unemployed. At the present time there is urgent demand for figures relating to the potential labor force—that part of our population not normally engaged in productive work for pay or profit which must be drawn into industry to meet the demands of our war economy. Moreover, there is need for current information on the occupational and industrial affiliation of workers for use in connection with the planning of production, the training of workers in occupations where shortages exist, the transfer of workers into new productive channels with maximum efficiency and a minimum of dislocation, and the location of new plants.

Great movements of population to important production or administrative centers have created new demands for housing requiring great outlays for new construction. The housing agencies in Washington and private construction organizations have made urgent requests for current housing statistics as a basis for planning new housing projects in a manner to meet the needs of the present emergency with a minimum of long-run difficulties. Up-to-date census statistics relating to rent would not only provide direct information on the changing cost of living, but would also be important as a base for the continuation of current indexes of rent changes.

Finally, there is a demand for current statistics from various agencies, including the National Resources Planning Board, to serve as a basis

for post-war readjustment. It may be safely stated that in the post-war readjustment period the need for statistics as a basis for action, administrative and legislative, will be as acute as the need for data in the emergency war situation. It will be necessary to have not only the basic statistics of the 1940 Census to tell us where we were at the onset of the war, but also current statistics to show where we have gone. It is only with these combined types of facts that adequate planning and administration can be effected during the trying times ahead.

These few illustrations of the demand for current population statistics suffice, perhaps, to make clear the need for such data for our immediate national defense and war efforts and for post-war readjustment purposes, as well as for more "normal" important governmental, industrial, and scientific uses.

Recognizing the importance of current statistics as a basis for mobilizing our human and material resources in the war emergency, and to meet the varied urgent demand for such data, the Bureau of the Census, in its role as a service agency, has devised a plan for the conduct of a sample census of population (and also of agriculture). Such a sample census might be taken on an annual basis, at least during the period of rapid change which confronts us. This plan is as yet entirely unofficial and has the character of a staff plan which could quickly be put into operation if desired. The essentials of this plan are briefly outlined in the paragraphs which follow.

The Type of Data to Be Obtained. The first schedule to be used if a sample census of population were taken would probably include inquiries which could be classified under three main headings: (1) General population, (2) the labor force, and (3) housing.

The questions relating to population would include age, sex, color, marital status, relationship to head, and place of residence on April 1, 1940, the date of the last census. The last of these questions would be designed to obtain the volume of in- and out-migration by comparing place of residence at the time of the sample census with place of residence at the decennial census.

The inquiries relating to the labor force might, in the first sample census, include employment status questions, similar to those on the 1940 population schedule, designed to indicate the number of persons in the labor force by their work status. These questions would also result in statistics relating to persons not in the labor force, showing their status during the cross-section week studied, and would be supplemented by inquiries designed to provide information indicating the potentialities of persons not in the labor force for labor force activity. The labor force inquiries might also include questions relating to occu-

pation, industry, and class of worker of persons in the labor force, with provision to obtain the occupation of persons not in the labor force.

The inquiries relating to housing would, in addition to the usual information indicating location, include questions on type of structure, general condition of the structure, age of structure, occupancy status of dwelling unit, number of rooms, and monthly rent for the tenant-occupied units, and estimated monthly rent for owner-occupied units.

These are the types of inquiries which it would be feasible to include in the proposed sample census. The final schedule would, of course, be determined only after consultation and clearance with consumers of census data. If the sample census were taken on an annual basis, a number of questions could be rotated from year to year so that the scope of the inquiries would be greatly expanded and proper interrelations of data obtained.

Estimates of Total Population. The most difficult question which the sample census would be called upon to answer is probably that relating to the total population of the area studied. Normally, estimates of the total population of an area would be dependent upon the use of an inflation factor obtained by comparing the population of the area studied on the sample census date with its population on the decennial census date. This method, however, would not only be expensive (because of the problem of obtaining decennial census figures for the areal units in the sample), but would, because of the relatively slow rate of change in total population, result in large sampling errors.

To meet this problem, it is planned to estimate the total population of a place by the "migration method." This would involve the application to the sample census data of the same technique designed for making intercensal population estimates from the 1940 Population Census migration statistics. The method essentially involves estimating the population of a place by adding to the population of the place as reported in the last census the number of births and in-migrants, and subtracting the number of deaths and out-migrants.

It is obvious that through the use of this method the error of the total population estimate is confined to the error in estimating migration and in the reporting of births and deaths. Approximate error formulas have been developed which, together with empirical studies which have been conducted, indicate that the migration method of estimating total population will usually be more precise than the method dependent on knowing the population of the areal units in the sample and in the preceding census.[1]

[1] This work has been done mainly by Morris H. Hansen, Acting Assistant Chief Statistician, Division of Statistical Research, Bureau of the Census.

It is planned to make statistics available for the United States, its regions and geographic divisions, the states, and cities having 100,000 or more inhabitants, or possibly 250,000 or more inhabitants, depending on the funds made available. To show areas smaller than these will require relatively large additional outlays probably beyond the realm of possibility for a reasonable sample census undertaking. The details with which the statistics will be reported for these various areas will, of course, vary with the size of the population, with the greatest amount of cross-classification being made available only for the United States as a whole or large subdivisions thereof.

The Design of the Sample.[2] The basic problem in the design of the sample for the proposed sample census of population is, of course, the determination of the character and number of sampling units to be used. Ideally, it would be desirable to select the same kind of sample as was selected during the 1940 Decennial Census of Population.[3] This would, of course, be entirely impracticable because of the huge expenditure which would be involved in obtaining the basic listing of the population.

The only feasible method of sampling, therefore, lies in the selection of geographic units of some kind. In selecting the sample areas the usual dilemma must be faced. Small areas are, of course, more efficient from a sampling standpoint, but large areas are easier to handle and cheaper to enumerate and tabulate. In designing the actual sampling plan contemplated, a compromise plan was effected which was calculated to have the maximum sampling efficiency within the limits of a reasonable expenditure of time and funds.

The proposed sample will consist of small areas scattered throughout the country and containing approximately 100 persons each. These areas, termed "parcels," will, in cities of 50,000 or more inhabitants, consist of city blocks or pieces of blocks. In the remainder of the country the parcels will consist of segments of the enumeration districts that were used in the 1940 Census. In rural parts of the country that have been surveyed and laid out on a township and range basis, the parcels may consist of sections or groups of sections.

The method of selecting the sample may be briefly outlined as follows: In cities of 50,000 or over, the large blocks (which might be defined as those containing 40 dwelling units or over) will be divided into two or more parcels. The sample parcels will then consist of whole small blocks, and pieces of large blocks, drawn by lot. The drawing

[2] The design of the sample is largely the work of Morris H. Hansen and W. Edwards Deming.

[3] F. F. Stephan, W. Edwards Deming and Morris H. Hansen, "The Sampling Procedure of the 1940 Population Census," this JOURNAL, December 1940.

will take place in such a way that the sample parcels are stratified geographically, which automatically gives fair representation with regard to a number of other factors.

In the territory outside the cities of 50,000 or over, where the blocks are not numbered, the enumeration districts will be stratified and divided into parcels as near the required size as is possible in the time allotted for preparation. The parcels for the sample will then be drawn by lot, proportionately from each stratum. The stratification will be geographic, and by its characterization as urban or rural, farm or nonfarm, in or not in a metropolitan district, by rent, color, and possibly by other characteristics. Although parcels so selected would constitute the main bulk of the sample, it would be necessary to draw samples from certain special universes, such as large institutions, prisons, army posts, large new apartment houses, etc., to guard against large sampling errors and administrative difficulties. Techniques have been devised to sample these special universes as may be required in different areas.

Precision of the Sample. On the basis of theory and actual experimentation, it is now possible to predict in advance the precision of the sample for the various characteristics and areas. Some important research[4] has been conducted in the Bureau of the Census in the determination of the most efficient sampling units. Studies have been made on the effect of stratification and size of parcel on the average intraclass correlation for various population characteristics. Knowledge of the behavior of the intraclass correlation coefficients enables sampling errors to be predicted for various sizes and kinds of sampling units, various sizes of sample, and various population characteristics. The work which has been done comparing predicted errors with observed errors in experimental sampling studies has demonstrated that the intraclass correlation coefficients have sufficient temporal and geographic stability to permit useful estimation of the sample errors.

In general, it may be stated that the results to be expected from the proposed sample, whether taken on an average 2 per cent or 5 per cent coverage (with variable sampling ratios for areas of different size), will have a relatively small sampling error and be adequate to serve as a practical basis for action for many administrative, legislative, or scientific purposes.

For example, it can be demonstrated that for a city having one million or more inhabitants with a normal amount of migration, the total population based on a 5 per cent sample can, on the average, be estimated with an error of less than four-tenths per cent and with an error

[4] This research has been conducted largely by Morris H. Hansen and William N. Hurwitz. (See pp. 89–94 *infra*.)

that will very rarely be as great as 1 or 2 per cent. Populations of smaller cities can be estimated with proportionately greater error.

Sampling errors will be smaller in estimating percentages than in estimating absolute amounts. This follows because the estimate of the absolute amounts will involve the use of an inflation factor which is also dependent on an estimate (that of the estimated total population of the area). For many purposes the relationships as expressed in percentages are the important desiderata, and, from a 5 per cent sample for a place having 250,000 or more inhabitants, such relationships as can be expressed by percentages can be estimated on the whole with an average error of less than 1 per cent for general population and labor force characteristics.

The average relative error in estimating an absolute amount for population and labor force characteristics (other than total population) would, for a place of approximately 250,000 persons, be less than 10 per cent, assuming that the total population is estimated by the migration method.

Relation of Sample Census to Decennial Census. The proposed sample census would, of course, have a number of limitations, most important of which would be its failure to provide even total population figures or simple counts of characteristics for small areas. The need for a complete inventory of the Nation's population can be met only by a complete census, and in a period such as this it may be necessary to take a quinquennial census of population to obtain the needed data for local inventory purposes.

The sample census would have an important bearing, however, on the complete census, whether taken decennially or quinquennially, in that it would provide a better basis for planning and conducting it. The complete census could be better interpreted in the light of the knowledge of changes recorded from year to year in an annual sample census, while these changes are taking place. Moreover, the sample and complete censuses combined would provide a time series, the significance of which, of course, would transcend that of the sum of the individual points in the series.

Perhaps an adequate program for the decade which faces us is one in which a sample census of population is taken in 1942 and 1943, a quinquennial complete census in 1945, and additional sample censuses in 1947 and 1948. This spacing would permit sufficient time for the adequate planning and conduct of the complete censuses while providing a reasonably current series of statistics.

It is not without significance that the German war effort was preceded by a great expansion of statistical activity to serve as a basis for

the mobilization of the German Nation in its total war effort. This Nation might well profit from the German example in planning its own emergency statistical activities. Failure to provide reasonably current statistics on budgetary grounds may prove to be a shortsighted and expensive economy.

This brief statement outlines the essential features of the proposed sample census plan. The urgent demand for current statistics calls for the conduct of the first sample census in the near future if the statistical needs of the various war and defense agencies are to be served adequately. The plan is ready and can be put into effect whenever authorization and funds are made available. There is no doubt that the proposed sample census would provide current statistics of great use for the better planning and administration of our war effort (and post-war readjustment), and that would certainly be its immediate and major purpose.

RELATIVE EFFICIENCIES OF VARIOUS SAMPLING UNITS IN POPULATION INQUIRIES*

By Morris H. Hansen and William N. Hurwitz
Bureau of the Census

In the planning of an annual sample census of population, agriculture, and housing, it has been necessary for the Census to consider the relative efficiency of different sizes of sampling units for estimating the characteristics of a finite population. We shall present some preliminary results that have been obtained in a few selected areas, and that are now being extended in a Work Projects Administration project sponsored by the Bureau of the Census. Later we shall present a summary of the work being done in this project.

The units of sampling that are being considered are: An individual person or household, or a small geographic area such as a city block, a segment of a block, a group of blocks, or a small rural area. Such sampling units will be referred to as clusters of elements, that is, clusters of dwelling units, farms, or people. For example, where a block is the sampling unit, the cluster of elements consists of all the persons or all the dwelling units in a block.

One of the principal problems which concerns us is to determine for a stratum which of these sampling units is most efficient, subject to cost and administrative limitations. We shall discuss the relative efficiency of different sampling units only in terms of the relative magnitudes of their sampling variances, where the variances are computed on the same unit basis.

When clusters of elements are the sampling units, the correlation between the elements within clusters will influence the sampling error. This can be seen from the formula[1] for the variance of a sample proportion or average, which involves the correlation between elements within

* A paper presented at the 103rd Annual Meeting of the American Statistical Association, New York, December 28, 1941.

[1] In the formula given, the number of elements is assumed to be the same for all clusters. Actually sampling units will vary in size, and the variance of a sample estimate must take account of the variability in the size of the cluster. If the average size of the cluster is $\overline{N}$, then a first approximation to the variance when clusters are the sampling units is

$$\frac{M-m}{M-1}\cdot\frac{PQ}{m\overline{N}}\cdot\left[1+\frac{\Sigma\rho_i N_i(N_i-1)}{M\overline{N}}\right] \text{ where } \rho_i=\frac{(P_i-P)^2-\frac{P_iQ_i}{N_i-1}}{PQ}.$$

The error in this approximation is given exactly by the expected value of

$$\left(\frac{\overline{N}_\alpha^2}{\overline{N}^2}-1\right)\left(p_\alpha-P\right)^2,$$

where $\overline{N}_\alpha$ represents the average of the N_i for a sample of m clusters, and p_α is the corresponding sample proportion.

sampling units. The variance of a sample proportion is given by the formula:

$$\sigma_p^2 = \frac{M-m}{M-1} \cdot \frac{PQ}{mN} [1 + \rho(N-1)]$$

where

N = number of elements per cluster,

P = proportion of elements in the stratum having a particular property,

M = total number of sampling units in the entire stratum,

m = number of clusters sampled,

p = proportion of elements in the sample having a particular property,

ρ = intra-class correlation between elements in the sampling unit, $= E(x_{ij}-P)(x_{ik}-P)/E(x_{ij}-P)^2$, where the symbol E preceding a quantity denotes the expected value. When evaluated for the finite population ρ is equal to

$$\left[\frac{\sum (P_i - P)^2}{M} - \frac{\sum P_i Q_i}{M(N-1)}\right] / PQ.$$

The summations are over all sampling units in the stratum.

The first factor, $(M-m)/(M-1)$, in the above formula for the variance is the finite population correction. The second factor PQ/mN, is the variance of a sample proportion if mN elements are sampled independently at random, with replacement. The third term is the factor which measures the contribution to the sampling variance of cluster sampling. If $N=1$, this third term becomes unity, and we have left the regular formula for sampling individuals at random. If N is greater than 1 (and M is large), we have $\rho(N-1)$ as the relative change in the sample variance from the variance obtained by sampling individuals at random. The influence of relatively small values of ρ, when N is large, is very striking. For example, if N is 100 and the correlation is only .05, the variance of a sample proportion is six times the variance obtained by sampling individuals. The relative efficiency in this case is one-sixth. If N is 1,000 and the correlation is .05, the variance is fifty times the variance obtained by sampling individuals.

For most population and housing items the correlation decreases as the size of the sample cluster increases. But usually the decrease in ρ is at a less rapid rate than the increase in N, so that, ordinarily, increases in the size of cluster lead to substantial reductions in efficiency. This will be illustrated later.

While usually the intra-class correlations encountered in practice are positive, and therefore the sampling of a cluster of elements is less

efficient than the sampling of individual elements, many important exceptions to this statement may be found.

Let us describe a physical situation which brings about a negative correlation, and therefore greater relative efficiency for a sampling unit containing a cluster of elements than for a single element. Assume that we wish to estimate the proportion of males in a population. First, let us restrict ourselves to 4-person households, each consisting of a husband and wife and two children. We shall assume that there are as many households in which both children are male as there are in which both children are female, and that these constitute half of the total households. The other half of the total households contain one child of each sex. This assumption agrees fairly well with the actual composition of 4-person households. The intra-household correlation for this assumed population is $-\frac{1}{6}$ or approximately $-.17$. This negative correlation reduces the variance when households are the sampling units to one-half the variance obtained when individuals are the sampling units, and hence the household is approximately twice as efficient as a sampling unit of a single person.

Physical situations for which the intra-class correlation is negative can be generalized as follows: If it is observed that an element in a cluster has a certain property, then it is less likely that the next element observed will have that property if it came from the same cluster than if it came from any other cluster.

Of course, in any actual population, households are not of the same size and do not follow exactly the sex distribution given in our hypothetical example. Results from actual observations, however, do not differ much from the results of our illustration. As examples, results are presented for two counties, one in Iowa and one in New Hampshire, each stratified by rural and urban within the county. In both the rural and urban parts of these counties we found that for estimating the sex distribution, the household sampling unit was approximately twice as efficient as the sampling unit of one person.

There are other characteristics for which the correlation between members of a household usually will be negative and for which the household will be a more efficient sampling unit than the individual. A similar situation, for instance, holds for the estimation of the proportion of persons 14 years old and over that are in the labor market. For example, in the county of Iowa considered above the relative efficiency for this characteristic was 1.4 in the urban part and 2.2 in the rural, and the corresponding values for the New Hampshire county were 1.6 and 1.5.

For practical purposes a sampling unit as small as a household may

not be administratively feasible. Moreover, the efficiency of sampling units for estimating the proportion of males in the population, or the proportion of persons in the labor market, is not typical of most population and housing characteristics. It is of practical importance to investigate efficiency of sampling units for other statistics and for clusters of elements larger than a household.

Results of analyses indicate that for most population and housing items a large size sampling unit is considerably less efficient than a small one. Such results were obtained, for example, from an analysis of 1939 data from Wheeling and Philadelphia for samples stratified by census tracts. This analysis shows that, for estimating the proportion of persons in specified age groups, say ages 5–14, blocks averaging between 150 and 200 persons, as sampling units, would be $\frac{1}{3}$ to $\frac{1}{2}$ as efficient as a sampling unit of one person.

For estimating the proportion of dwelling units that are owner-occupied, the block as a sampling unit in these two cities was found to be $\frac{1}{3}$ to $\frac{1}{2}$ as efficient as a single dwelling unit. This loss of efficiency arises from the fact that within a stratum most of the dwelling units in some blocks may be owner-occupied, while most of the dwelling units in other blocks within that same stratum may be tenant-occupied or vacant.

The efficiency of the block is quite different for estimating moderate vacancy rates. For example, in the same cities the block was found to be nearly as efficient as a household for estimating strata vacancy rates less than .02. Its efficiency decreases to approximately 3/10 to 7/10 for estimating vacancy rates over .02. These results arise from the fact that, at least for these cities, in 1939, the intra-block correlation for moderate vacancy rates is close to 0 while for vacancy rates above, say, .1, the correlation is relatively high.

In rural areas and small cities, segments of enumeration districts may serve as the sampling units. For estimating the proportion of males 5–14, in rural areas within counties, a cluster consisting of five households, or 20 persons, was found to be .8 as efficient as one person, clusters of 10 households slightly less, while an entire enumeration district averaging 250 households was found to be only 1/20 to 1/10 as efficient as one person.

The loss of efficiency with an increase in the size of sampling unit is particularly pronounced in estimating the proportion of dwelling units that are owner-occupied. The efficiency of a segment containing five households was about 8/10 that of a single household, and dropped to 1/10 when the enumeration district was considered as the sampling unit, and in some instances as low as 1/100.

It is to be pointed out that the relative efficiencies of different sampling units are not independent of the system of stratification.

The above results are tentative, being based on only small scale experiments, but they give a general idea as to the relative efficiencies of different sizes of sampling units for estimating population and housing items. They are now being extended in a WPA project which the Bureau of the Census is sponsoring in New York City. The study is based on more than 1,000,000 names selected from the 1930 Census schedules, and approximately 500,000 names from the 1940 schedules drawn from cities and counties throughout the United States.

The investigations are being extended not only to alternative random sampling designs but also to systematic designs such as taking every n-th person, or household, or block within a stratum. Thus, detailed information will become available concerning factors which influence the choice of a sampling design, such as gains from stratification, the utility of sub-sampling, and the effect of variability in the sizes of the sampling units. The results of the analysis of 1930 and 1940 data and some less extensive results for intra-census years will make it possible to determine the relative temporal and geographical stability of some of the factors which are involved in the sampling theory. Thus, the study of the relative efficiencies of different sizes of sampling units is only one phase of this WPA study.

We shall conclude with a word about the choice of a mathematical model. The model we are now using is a finite population, and the variances and correlations are evaluated for the finite population. There are other models, that might have been used, among which the one posed by Cochran, and by Yates and Zacopanay, is outstanding. As commonly used, the latter model assumes that the finite population is a sample from an infinite population; and if the population is divided into clusters, each element can be expressed as the sum of two quantities, one of which is constant for all elements in a cluster but varies independently from cluster to cluster, the other varies independently within clusters. This model, however, does not permit negative correlation, and hence a cluster of elements according to this formulation can never be more efficient than a single individual. This is not identical with some of the physical situations given above.

Suppose that the finite population within which we are sampling consists of M sampling units, each unit consisting of N elements. Suppose further than m such clusters are sampled. Then this model leads to

$$\sigma_p^2 = \frac{(M-m)}{M}\left\{\frac{\sigma_b^2}{m} + \frac{\sigma_w^2}{mN}\right\}$$

as the variance of the sample proportion, p, around the finite population proportion; where σ_b^2 is the variance of the quantity which is constant for all the elements within a cluster but varies from cluster to cluster, and σ_u^2 is the variance of the quantity which varies within clusters.

Now suppose that mN elements are sampled individually. Then the variance of the sample proportion, p', around the finite population proportion is

$$\sigma_{p'}^2 = \frac{(M-m)}{Mm} \cdot \frac{\sigma^2}{N} \quad \text{where} \quad \sigma^2 = \frac{N(M-1)}{MN-1}\sigma_b^2 + \sigma_u^2.$$

It can be shown that $\sigma_p^2/\sigma_{p'}^2$ cannot be less than 1, and therefore, under the analysis of variance formulation, a sampling unit consisting of more than 1 element can never be more efficient than a sampling unit of a single element. This is in contradiction, as illustrated earlier, to the physical situation where the intra-class correlation between elements within a sampling unit is negative. A modification in the model, such as the one Yates and Zacopanay made to take care of the so-called "Competition" between elements within a sampling unit, would be necessary in order to have a model which more closely corresponds with all possible physical situations.

RECENT DEVELOPMENTS IN SAMPLING FOR AGRICULTURAL STATISTICS*

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Our title is broader than the subject matter we propose to discuss. We shall limit our remarks to recent developments in the research conducted at Ames, Iowa, by a group of representatives of the Agricultural Marketing Service and Iowa State College.

Investigations in sampling are divided broadly into two categories: those pertaining to somewhat extensive surveys and those of the more restricted kind associated with experimentation. Although we have not recently been active in the study of experimental design, Cochran, Autrey and Cannon[1] have given an account of a design for a switch-over type of experiment in which three or four treatments are administered successively to each experimental animal. This plan makes it possible to estimate carry over effects and to adjust for them, thus providing accurate comparisons of the results of the treatments and unbiased estimates of the experimental errors. The design is especially valuable in experiments where the milk production of dairy cows is the variate investigated, because due allowance is made for decreasing flow with advance of the lactation period. Since three rations were to be fed to eighteen cows, each for six weeks, the cows were divided into six groups of three so that the members of a group were about equal in known performance. The three cows of each group were given the three rations in sequences forming a Latin square. The use of a pair of complementary 3×3 squares, three groups being assigned to each, provided the adjustment for carry over effects. The solution is effected by applying the principle of least squares to equations in which the observed milk yield of any cow is expressed as a linear function of the effects of the cow's yielding ability, the period, the current and previous rations, and the experimental error. The design attained a satisfactory precision in this feeding experiment, the standard error being 1.5 per cent of the mean.

Turning now to the more extensive types of sampling in agricultural statistics, we consider first the work which Messrs. Jessen, McCarty and Houseman have been doing, in which they have investigated the impact of cost on sampling design. The maximization of information for a set total expenditure may lead to notably different designs from those set up from no other than statistical considerations. The proced-

* A paper presented at the 103rd Annual Meeting of the American Statistical Association, New York, December 28, 1941.

[1] "A Double Change-over Design for Dairy Cattle Feeding Experiments," by W. G. Cochran, K. M. Autrey, and C. Y. Cannon, *Journal of Dairy Science* 24: 937, November 1, 1941.

ure which has been used is to derive not only a variance function but also a cost function, then minimize the former for fixed values of the latter. Two examples can be given.

Jessen[2] has examined the efficiency of a sample of some 800 Iowa farms, the variates being numerous items of agro-economic interest such as acreage, production, income and expenditure. The sampling unit in this survey consisted of the farms for which farmsteads lay in a quarter section, this unit lending itself conveniently both to random selection and to expansion of the sample means into state totals. The time consumed by each questionnaire was about an hour. From examination of the variance function alone, it was evident that in this survey the quarter section sampling unit was the most efficient of the grids, but that the individual farm would be advantageous as a unit if the difficulties of sampling, expansion, etc., could be avoided.

The consideration of cost revealed that with smaller total expenditure and shorter questionnaires larger sampling units would be more efficient. Let us consider each of these conditions. High costs of travel require larger sampling units. Although this increased taking of schedules in each chosen locality is statistically less efficient than the more diffuse placement of smaller units, it is economical of mileage. Hence, it is efficient to sacrifice some information for each schedule in order to obtain a greater number of returns cheaply. Similarly, short questionnaires make for larger sampling units, because, the cost per schedule being small, it is possible to secure many in every location. The increase in the number of schedules thus obtained compensates somewhat for the lower statistical efficiency per schedule. More restricted funds for sampling likewise force the taking of larger as well as of fewer sampling units. Thus, information per unit, as well as total information, is sacrificed to cost.

This finding emphasizes the desirability of small sampling units for the long questionnaires usually required in surveys such as those taken in farm management research. Here the individual farm is usually indicated as the most efficient unit, and may also be the most practical one if ways can be found to make effective random choice. This is especially true if expansion of the sample means is not desired.

A second example of a sample cost study is reported by King, McCarty and McPeek.[3] This study is based on the 1940 pre-harvest wheat survey in Kansas, a route sampling in which the sampling unit is

[2] "Statistical Investigation of a Sample Survey for Obtaining Agro-economic Facts," by Raymond J. Jessen accepted for publication as a research bulletin by the Iowa Agricultural Experiment Station.

[3] "An Objective Method of Sampling Wheat Fields to Estimate Production and Quality of Wheat," by Arnold J. King, Dale E. McCarty, and Miles McPeek, accepted for publication as a U.S.D.A. Technical Bulletin.

designated as one field to each mile of wheat along a checkerboard route. In every such field two patches of wheat, each of about one five-thousandth of an acre in area, and selected at random, were harvested. The Kansas sample comprised 1,100 fields.

The variance function set up by Mr. E. E. Houseman for this study included not only the variance of the stratified sample of acre yields, but also the variance of the estimate of wheat acreage included in the survey. Since consideration of costs in this sampling led to a change in recommendations about the appropriate design, the findings will be described in some detail. The cost function was linear in two variables: first, the expenditures associated with the sampling in a field, and second, those incident to travel between sampled fields. When cost was taken into account, it was found that because of the low cost of travel as compared with high laboratory cost of processing the samples for yield and quality, the efficiency of the sample could have been increased by 122 per cent over that of the sample as actually taken. Before the survey, little information on cost and variability was available, so the choice of interval between fields sampled and the distance to drive was made only by approximation. Upon considering cost it was found that the 122 per cent increase in efficiency accrued from taking only one unit per field rather than two, from increasing the interval between the fields sampled, and from expending the money by more than doubling the length of the miles traveled and increasing the number of fields sampled from 1,150 to 1,250. It should be explained that the advantage of increasing the length of route lies in the assumptions that total acreage is estimated by the ratio of wheat frontage to total frontage, and that the variance of this estimate is inversely proportional to the distance traveled—assumptions which have been found not unreasonable by W. A. Hendricks.

Another investigation, in character not unlike the cost study, relates to all those inquiries involving the values of two or more variates—usually many of them. Since each variate has a variance peculiar to its own distribution, to obtain the most efficient allocation of the sampling to the several strata it is usually necessary to allocate separately for every one of them. Miss M. L. Bucher is examining a compromise allocation which promises satisfactory results. This is reached by maximizing the sum of the amounts of relative information in the several variates. By relative information for each variate is meant the ratio of the information in the sample with the compromise allocation to that in a sample with optimum allocation. Neyman[4] found that this opti-

[4] "On the Two Different Aspects of the Representative Method; The Method of Stratified Sampling and the Method of Purposive Selection," by Jerzy Neyman, *Proceedings of the Royal Statistical Society* 97: 558, 1934.

mum allocation for a single variate is that in which the number of sampling units for the ith stratum is proportional to $N_i\sigma_i$. We have, then,

$$\text{relative information} = \frac{\dfrac{1}{V_x}}{\dfrac{1}{V_{\bar{0}}}} = \frac{V_{\bar{0}}}{V_x} = \frac{\{S(N_i\sigma_i)\}^2/Sn_i}{S\dfrac{N_i^2\sigma_i^2}{n_i}}$$

where V_x and $V_{\bar{0}}$ are the variances in the compromise sample and the optimum sample, respectively, and n_i is the size of sample in the ith stratum.

The maximization of the sum of the amounts of the relative information leads to equations difficult to solve. In most cases tried, however, the third successive approximation gave satisfactorily stable results. We present in Table I the relative information in each of a group of items from two samples, listing first the relative information in the

TABLE I

PER CENT RELATIVE INFORMATION IN ACTUAL AND THEORETICAL SAMPLES

	Iowa		Indiana	
	Actual sample	Theoretical sample	Actual sample	Theoretical sample
All corn	98.36	98.80	92.56	96.96
Corn grain	97.89	98.20	92.00	96.07
Silage	84.73	81.28	79.29	82.30
Fodder	73.37	69.33	64.54	72.41
All oats	97.06	98.28	87.88	93.05
Oats grain	96.44	97.38	81.01	92.13
Barley grain	61.28	71.77	67.88	72.90
All wheat	71.40	75.55	92.10	95.08
Winter wheat grain	66.67	68.56	92.17	95.19
Summer wheat grain	58.29	69.63		
Rye grain	67.56	70.42	83.76	93.22
Popcorn	35.92	44.01		
All soybeans	94.26	90.69	85.53	94.69
Soybeans grain	89.41	86.63	77.24	87.23
Soybeans hay	98.08	95.39	94.04	97.76
Potatoes	32.51	38.07	41.99	53.66
Flax	64.24	73.28		
Alfalfa hay	97.16	97.09	94.05	85.80
Clover timothy hay	87.52	79.33	98.71	91.37
Tobacco			49.19	62.38
Cowpeas			51.29	64.04

samples as taken, and second that in samples with maximum sum of relative information. The compromise allocation produces an increase in the relative information of all of the poorly estimated items, with

corresponding decrease in only a few of those well estimated, a compromise which seems reasonable.

The value of this research lies not so much in the compromise reached, in which many items still are poorly sampled, but in the isolation of those items which cannot be well estimated along with the majority. The segregation of these items gives the sampler the choices of omitting them from the schedule, of proceeding with full knowledge of the small amount of information available, or of setting up separate samplings designed to elicit required information about them.

We turn now to another type of inquiry. Mr. J. R. Goodman has been working on an application of the double sampling technique in the estimation of corn yields from route survey data. The yield estimates resulting from this objective sampling are based upon two factors: (1) average number of ears per unit area, and (2) average dry weight of kernels per ear. The sampling procedure follows the principles laid down by the pre-harvest wheat surveys, with stops made at regular intervals along the route traveled. The point of entry of the field is selected as nearly as possible at random and the sampler proceeds twenty rows into the field in order to eliminate border effect. Within the field the sampling unit for the number of ears is a ten-hill area, that for size of ears (dry weight of kernels per ear) is a single hill. The ears from this one hill per field are measured, harvested, and brought to the laboratory for determination of dry weight of kernels per ear. In contrast with this expensive procedure, counts of ears can be made at little cost; hence, three sampling units for this variate were located in each field sampled.

The high cost of making dry weight determinations suggested the possibility of a double sampling in which ears would be measured in many fields but harvested in only a portion of them. From ear measurements taken in this and a number of earlier surveys, comparison could be made between the sampling as it was done and the proposed double sampling. It was known that the product of length times diameter of ear is highly correlated with the dry weight of kernels; hence, the dry weight of kernels per ear could be estimated by the formula

$$E_Y = \bar{y}_s + b(\bar{x}_L - \bar{x}_s)$$

where $\bar{y}_s$ is the average dry weight of kernels for the small harvested sample Y_s

$\bar{x}_L$ is the average size (length×diameter) of ear for the larger sample in which measurements only are taken

$\bar{x}_s$ is the average size of ear for the small sample

and b is the regression coefficient for the regression of y on x.

The variance of the estimate is given by the formula

$$V(E_Y) = \sigma_Y^2\left[(1-\rho^2)\left\{\frac{1}{n}\right\}+\frac{\rho^2}{N}\right]$$

where ρ is the correlation between the size of ear and the dry weight of kernels in the population

n = the size of the small sample

and N = the size of the large sample.

The formula[5]

$$V(E_Y) = \frac{S(Y_s-\bar{y}_s)^2}{n-2}\left[(1-r^2)\left\{\frac{1}{n}+\frac{N-n}{N}\,\frac{1}{n(n-3)}\right\}+\frac{r^2}{N}\right]$$

gives an estimate of the average variance in double sampling, based on the small sample values for mean deviation from regression, and using the expected value for $(\bar{x}_L-\bar{x}_s)^2$.

Since data were available for two states, Iowa and Illinois, we estimated in each of them the variance of E_Y for a double sampling in which the number of dry weight determinations, n, was 50, while the fields with ear measurements, N, was 200. In each state the relative standard error (coefficient of variation) turned out to be about 2½ per cent. Results of the investigations are indicated in Table II. While more fields would be visited in the double sampling, only 50 dryweight determinations would be required instead of 160. The saving in laboratory costs more than compensates for the additional field measurement. Hence, it appears that double sampling may prove advantageous in the route survey work on corn yield.

TABLE II

VALUES OF n AND N FOR SAMPLINGS OF EQUAL EFFICIENCY BY TWO METHODS

Method	n Determinations of dry weight	N Ear measurements	Total fields
Simple sampling	160	0	160
Double sampling	50	200	200

The routine procedures of such agencies as the Census, the Bureau of Agricultural Economics, and the Division of Agricultural Statistics involve sampling repeated at regular or irregular intervals. Thus, the question of the efficiency of matching all or part of the sampling units in a later sampling with those in an earlier has received much atten-

[5] Developed by Professor W. G. Cochran.

tion. We have made two attacks on the problem with results that seem informative.

Jessen[6] designed his 1939 sample so that approximately half of his sampling units were drawn at random (within the strata) from those of 1938. He first considered the efficiency with which means in 1939 were estimated from this incompletely matched sample as compared with one wholly independent. The item means of the matched portion of the 1939 sample were adjusted by use of their regression on the 1938 means, and the variance of these adjusted means computed. The 1939 sample thus furnished two independent estimates of the population mean, one from the matched half and a second from the unmatched, the variances of the two estimates being different. The population mean was then estimated by weighting the means of the two halves each with the reciprocal of its own variance. For 14 items in the questionnaire, the relative efficiency of the half-matched sample as compared to one completely unmatched ranged from 122 to 145 per cent—if correlations had been perfect in this 50 per cent matched sample, the gain would have been 50 per cent for all items.

Another problem considered was that of determining the optimum allocation of sampling units among the three categories of a sampling design involving incomplete matching: (1) the first year's sample size, (2) the matched sample of the subsequent year, and (3) the unmatched sample of the subsequent year. It was assumed that the population variance was the same at the two samplings and that the sampling units were obtainable at equal and constant unit costs. For several values of the population correlation, ρ, and for a sample of 1,000 the first year, the following were the values of the matched and unmatched portions of the second year's sample:

	$\rho = \pm 0.5$	$\rho = \pm 0.9$	$\rho = \pm 0.98$
Matched	498	443	349
Independent	431	193	70
Total	929	636	419

It was found that if there is no correlation, it is a matter of indifference whether matching is done or not, but the second year's total sample must be the same size as the first, 1,000 each year. The table shows that the gain in size of total sample would be pronounced only for rather high correlations, and that some independent samples are needed no matter how high the correlation. Clearly, under the conditions of this sampling, matching close to half of the second year's units leads to a saving in cost.

[6] *Loc. cit.*

The conditions leading to this result should be emphasized. About one-third of the sampling units bore no farmsteads, so that the values of both variates in the regression were zero. This led to higher correlations than might ordinarily be encountered.

In quite a different situation, the question regarding the efficiency of matching crop acreages has been investigated by Mr. Houseman. He worked with returns from the inquiries distributed by rural mail carriers for the Agricultural Marketing Service in the Department of Agriculture. It has been the practice in the Agricultural Marketing Service to list separately the farmers reporting for two years in succession. The matching of these farms and the sending of follow-ups to those who do not report run into a considerable cost. The problem was to determine the extent to which this separate listing improves the estimate and to learn if this is an efficient way to spend the money. Houseman finds that for estimating acreages in Iowa the present method of matching farms is of practically no value. Also, because of correlation between the matched farm estimate and the more accurate ratio to land estimate which is made from the data, the matching cannot at best supply much additional information. In this kind of investigation, it is rather important that proper weights be used in combining the two estimates; otherwise, the use of the matched farms may result in a loss of information.

We have thus reached opposite conclusions about the value of matching in two instances of agricultural sampling. Both results have been somewhat surprising. Apparently the complex conditions surrounding such samplings will require many individual investigations into their efficiency.

THE MEANING OF PRODUCTIVITY INDEXES*

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Following the 1929 collapse, much attention was focussed on the subject of increasing labor productivity, mainly because of its close association with the problem of unemployment. More recently, the center of interest has shifted. Today we are striving to combine our human and material resources in such a manner as to maximize our production of war items without at the same time curtailing dangerously the manufacture of civilian essentials. Every improvement in productivity, wherever it occurs, contributes to this end. Later, when the immense task of post-war readjustment must be undertaken, progressive productivity increases may perhaps again be regarded as not an unmixed blessing. Because of these increases, we must achieve a higher scale of living than any we have ever before enjoyed, or face the prospect of persistent unemployment.

In recognition of this continuing interest in labor productivity, its background, and its implications, the Congress recently authorized the establishment in the Bureau of Labor Statistics of the Productivity and Technological Developments Division. This Division has, among its other activities, undertaken the continuation and extension of certain studies made by the National Research Project of the Work Projects Administration. It is engaged in the construction of index numbers of productivity and unit labor cost for an increasing number of industries. In addition to maintaining these quantitative historical records, it is endeavoring through field studies to ascertain unit labor requirements in selected industries. It is also collecting information on current technological and related developments which may provide some clue as to the future course of productivity.

To this new Division, employees of various branches of the government service and representatives of labor, management, and the public have been turning in increasing numbers for information and statistics relating to productivity. Through such daily contacts, we have been able to learn at first hand something about the demand side of the market for productivity indexes. We have also become aware of certain misconceptions which are prevalent among productivity-index consumers regarding the nature, proper use, and limitations of such measures. In this paper, we discuss certain points which should be taken into account in the interpretation of the types of productivity measures usually constructed.

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A theoretical point which appears most puzzling to lay minds is the multiplicity of possible productivity indexes for, say, a manufacturing industry. Most consumers of productivity indexes approach us with the firm conviction that there must exist a unique and unequivocal productivity index referring to the particular segment of economic activity in which they are interested. To shake this conviction however so slightly, we are usually obliged to fathom the depths of our resourcefulness—and, sometimes of our inquirer's patience.

Without going into the history of a controversy which once raged among statisticians themselves, we note the cardinal fact that, even with ideal data, a number of plausible productivity indexes may be constructed. Our choice is reduced to but one of these many alternatives only when the question asked about productivity change is so specific as to be equivalent to a verbalization of only one of the many possible indexes, thus precluding all indexes other than that particular one. Even if we restrict ourselves to the ordinary weighted aggregative type of index numbers, we have a whole family of permissible measures, each answering a significant variant of the same fundamental question. Each variant depends on the particular complex of quantities chosen for the products included in the productivity index, and the number of possible quantity complexes, real and hypothetical, is without limit.

In reply to a more sophisticated inquirer, we may resort to a symbolic demonstration. To simplify the discussion, we turn from productivity to the unit labor requirement, which is the reciprocal of productivity. For a single uniform product, the unit labor requirement for any particular time is the labor consumed per unit of output of the specified good; or, what amounts to the same thing, the ratio of the total labor required for the production of a given volume of a homogeneous good to the given volume of that good.[1]

The unit-labor-requirement index for a single homogeneous product is merely the ratio of the unit labor requirements for the times t_i and t_0, where t_0 denotes the base period.[2] Symbolically, this may be expressed as follows, where I_r represents the index of unit labor require-

[1] The preferred measure of labor is generally man-hours rather than the number of men. As is pointed out later, all labor time is of necessity regarded as additive; the nature of the available statistics usually does not permit any distinction to be made between hours of different intensity or hours of different kinds of workers.

[2] It should be noted that productivity indexes as usually constructed reflect fluctuations in the degree of capacity utilisation, as well as influences of a more permanent character. For various purposes, it would be desirable to construct productivity indexes which would be independent of changes in the degree of capacity utilisation. Such indexes by inference would involve, in both numerator and denominator, estimates of unit labor requirements at the same operating level. The unit labor requirements would be wholly hypothetical if the operating level assumed for the comparison differed from that actually attained. Since, in general, the data available do not permit the construction of such measures, the discussion in the text is limited to the more usual indexes.

ments, I_p represents the productivity index, and r_i and r_0 denote the unit labor requirements at times t_i and t_0, respectively:

$$I_r = \frac{1}{I_p} = \frac{r_i}{r_0} = \frac{q_x r_i}{q_x r_0} = \frac{m_{xi}}{m_{x0}}. \tag{1}$$

It may be observed that the index is also equivalent to the ratio of the total amount of labor required to produce any specified volume of the good in question at t_i to the total required for the same volume at t_0. This has been shown in equation (1) by introducing q_x, which represents the specified volume, and m_x, which denotes the required amount of labor. It should be noted at this point that, whatever the quantity q_x, the index for one product is invariant.

For the more important case of an industry producing a number of products, we need merely relate the total volume of labor required to produce a given complex of quantities at $t_i(M_{xi})$ to the total volume required for the same complex at $t_0(M_{x0})$. We may represent such an index for n goods as follows:

$$I_r = \frac{M_{xi}}{M_{x0}} = \frac{\sum^{n} m_{xi}}{\sum^{n} m_{x0}} = \frac{\sum^{n} q_x r_i}{\sum^{n} q_x r_0}. \tag{2}$$

The totals are, of course, equivalent to the sums of the totals for the individual products.

Now, there is a very important difference between the labor requirement (or productivity) index for a group of products and the labor requirement (or productivity) index for a single product. An index for one product, as we have already observed, is invariant since it depends in no way on the quantity of output assumed. An index for many products, however, does vary according to the quantity complex assumed. Now, the quantities for t_i (i.e., the $q_x = q_i$) generally give a different result from that given by the quantities for t_0 (i.e., the $q_x = q_0$); again, hypothetical quantities may give still different results. In some cases, the differences are unimportant; in others, they may be considerable. Which of the infinite number of possible indexes is correct? It all depends on the quantity complex one has in mind. If one does not specify a particular quantity complex, none of the indexes is necessarily best, and there is no basis for choosing one above all the others.

The bald question, "How much has productivity increased in a given multi-product industry?" may be compared with the question, "How much larger is one house than another?" A variety of answers to the latter question might be given—depending on whether the number of

rooms, the cubic space enclosed, the ground area covered, or the construction cost is adopted as a criterion. In the same way, the former question has no single numerical answer unless a particular quantity complex is specified as the desired criterion.

We are frequently asked to appraise productivity indexes constructed from actual data. Almost invariably, the formulas used differ from those we have discussed above and the methods are less direct. The available data, moreover, are not complete, nor are they perfect within their restricted compass. The net result of compromise, assumption, substitution, ingenuity—and, sometimes, vagueness of purpose—is seldom ascertainable.

It is essential before attempting to evaluate an actual productivity index to know what formula is being approximated. The selection of a formula, however, is not often a "conscious" act. Availability of data is usually the factor which determines the choice.

Equation (3a) represents the general form of a proper productivity index. In it, the quantities of the individual goods involved, the q_x, may be real, referring to actual production in any period of time, or hypothetical. In equations (3b) and (3c), the quantity complexes are those of the base period, t_0, and the index period, t_i, respectively. To many, these latter forms appear inherently more "reasonable" than those involving other quantity complexes.

$$I_{px} = \frac{1}{I_{rx}} = \frac{\sum^{n} q_x r_0}{\sum^{n} q_x r_i} \tag{3a}$$

$$I_{p0} = \frac{\sum^{n} q_0 r_0}{\sum^{n} q_0 r_i} \tag{3b}$$

$$I_{pi} = \frac{\sum^{n} q_i r_0}{\sum^{n} q_i r_i}. \tag{3c}$$

The form indicated by equation (3c) is the one usually chosen, consciously or otherwise, for actual evaluation of a productivity index. The evaluation of equation (3a) or (3b) implies knowledge of the unit labor requirements (or numbers proportionate to them) for all the goods involved for each of the years. In contrast, the individual unit labor requirements for only the base year are needed for equation (3c); the denominator may generally be obtained directly as total man-hours of labor expended in the period t_i.

Estimates of the unit labor requirements in the base period are sometimes available, perhaps from the results of sample field studies. Usually, however, the available figures do not cover all the goods produced by an industry. If the r_0 cannot satisfactorily be estimated for all products, equation (3c) will not give an index of unity for the base period. It may, however, be adjusted as follows to achieve this result:

$$I_{pi}' = K \frac{\sum^{n-z} q_i r_0}{\sum^{n} q_i r_i} = \frac{\sum^{n} q_0 r_0}{\sum^{n-z} q_0 r_0} \cdot \frac{\sum^{n-z} q_i r_0}{\sum^{n} q_i r_i} . \tag{4}$$

Here the symbol z is used to denote the products for which unit labor requirements in the base period are not available.

Now, equation (4) may be rewritten as follows:

$$I_{pi}' = \frac{\sum^{n-z} q_i r_0}{\sum^{n-z} q_0 r_0} \Big/ \frac{\sum^{n} q_i r_i}{\sum^{n} q_0 r_0} . \tag{5}$$

In this form, the numerator is a production index (aggregative form) for the several products with r_0 weights. The denominator is the index of total man-hours for all the products. The quotient form of a productivity index is very common, and most actual productivity indexes are derived in this form.[3]

But our retreat from precision toward approximation does not end here. Frequently, estimates of the r_0 are not available for even a few products. Consequently, those who construct production indexes to be used in measuring productivity generally substitute other weighting factors more or less related to unit labor requirements. Unit labor costs are regarded as a first approximation, since they will be proportional to unit labor requirements if average hourly earnings in the production of the several goods considered are the same.[4] These weights also are seldom available, so value added by manufacture per unit of product, if it is available, may be used as a second approximation. In this case, the

[3] Usually, the production and man-hours indexes are not comparable in scope for the additional reason that the quantities entering into the production measure refer to output of *all* establishments while the man-hours index is restricted to the establishments in an "industry." Some investigators, like Dr. Fabricant (in *Output of Manufacturing Industries: 1899–1937*) prefer to make a formal value adjustment by the use of Dr. Mills' "value-adequacy ratio" or its equivalent. By such an adjustment, they hope to correct for the omission of the z products from the production index and for all other differences in scope between the production and man-hours indexes.

[4] In this paragraph and the following, a discussion of the condition of equivalence of indexes with different sets of weights is, for simplicity, restricted to the case of proportionality. Proportionality, however, is merely a sufficient and not a necessary condition; it may be shown, for example, that equality results whenever certain correlation coefficients reduce to zero. (See I. H. Siegel, this JOURNAL, September 1941, pp. 343–350, and December 1941, pp. 519–524.)

additional assumption is made that wages constitute the same proportion of value added by manufacture for each of the products. Unit value is the next step in the line of approximations; the validity of its use depends, in addition to all prior assumptions, on the constancy from product to product of the ratio between value and value added. Unit value is probably the most commonly used weighting factor, since it is frequently available for the more important products of an industry from the Census of Manufactures. When unit values are lacking, recourse may be had to wholesale prices as weights. These, of course, will be influenced by the additional factor of distribution costs.

It thus comes about that production indexes constructed for measuring productivity changes are frequently like indexes constructed for measuring production *per se;* the latter often are of the aggregative form and also embody pecuniary weights, though by choice rather than necessity. Hence, a much more usual approximation than (5) is the following:

$$I_{pi}'' = \frac{\sum^{n-z} q_i v_z}{\sum^{n-z} q_0 v_z} \Big/ \frac{\sum^{n} q_i r_i}{\sum^{n} q_0 r_0} \tag{6}$$

where the v_z are substitute weights, usually unit values for one or more years.

The widespread and unfortunate assumption that a productivity index can be satisfactorily obtained by relating any production index to a man-hour index probably has its origin in the form of equation (5). Needless to say, unless we are to revise our basic notions of labor productivity, the result will be valid only when the production index employed is a satisfactory approximation to the proper aggregative production index with labor-requirement weights for all products.

The approximative formulas given above are by no means exhaustive. Some of the production indexes actually used in constructing productivity measures are not of the weighted aggregative type, but, rather, are geometric means of relatives or are of the unweighted aggregative type. Some indexes are based on substitutes for output altogether, such as sales, shipments, or consumption. Finally, there are many problems of chronological continuity, which necessitate various adjustments; such adjustments, in effect, make the formulas actually used more complicated than those here shown.

The validity of an approximative index of the kind discussed here depends upon how closely it conforms to the "true" index, which, explicitly or implicitly, is as defined in equation (3c). The degree of similarity, of course, is usually unknown. If it could be ascertained in some

cases, it might provide some clue to the error to be expected in other cases where no direct comparison of the true and approximative indexes is possible. Thus, it is of interest to know whether the production index in (5) for a few products with r_0 weights adequately represents the index for all or most products with r_0 weights. It is also of interest to know whether substitute weights of the kind used in (6) really tend to be proportional to the r_0, so as to give us a close approximation to (3c).

The WPA National Research Project undertook, in the course of constructing its indexes, to test approximative methods wherever possible. The opportunities were few and the tests by no means definitive. The results indicated that approximative indexes were adequate over long periods but not so trustworthy for year-to-year changes. In extreme instances, the unit labor requirements may tend to be inversely related to the substitute weights. In such cases, the derived productivity index may even lie outside the range of the productivity relatives for the individual products. No "directly" computed productivity index would give such a result, for such an index is always equivalent to an average of the productivity relatives for the individual products.

A large demand exists for monthly or other short-term productivity indexes. Unfortunately, many obstacles lie in the way of either interpreting such short-term measures properly or even obtaining satisfactory data in the first place. Consequently, we are reluctant to construct short-term productivity indexes and hesitate to "sanction" any referred to us for criticism.

The difficulties which beset the construction of correct annual indexes also beset the construction of indexes for short periods. But there are other difficulties peculiar to short-term indexes which are even more serious. For example, the cycle of production may be longer than the —say, monthly—period for which the index is constructed; consequently, the labor expended in any month may correspond only partly to the output reported for that month. Furthermore, since it is difficult to obtain production series on a short-term basis, resort is very frequently had to substitute quantity series such as shipments or consumption.[5] These substitute series may give an absolutely false indication of the short-term movements of the true weighted output. They may lag behind or lead true production; the magnitude and direction of the changes they indicate may be spurious, especially if there is storage between stages of production and the cycle of fabrication is longer than one month.

Even if the available data are in satisfactory form, the significance

[5] In some instances, for want of something better, man-hours series themselves are used as indicators of production.

of short-term productivity movements may be obscure. If an industry produces different goods through the year, the month-to-month movements may reflect differences in the composition of the output, as well as true changes in level. In any industry, and particularly in seasonal ones, monthly productivity changes may be dominated by changes in the degree of capacity utilization. In such cases, it would indeed be difficult to disentangle seasonal variations from longer-term trends—except in retrospect. Thus, it may be said categorically that any monthly productivity index constructed from currently available data should be used with caution. Preliminary investigations, however, indicate that in some cases indexes constructed on a less-than-annual basis may convey useful information not revealed by simple annual averages.

The nature of an index of productivity is often misunderstood. Those who regard it as a touchstone are frequently chagrined to find that it reports the base alloy together with the gold. Some of our inquirers seem to believe that, since such an index is frequently called a "labor productivity" index, it reflects changes in output per unit of labor which are attributable principally to essential improvements in labor efficiency. Others tend to interpret the changes as resulting from changes in technology alone. Neither of these views is correct. Increases in output per unit of labor reflect the joint efforts of all factors of production; sometimes one factor may dominate and sometimes another.

As has already been indicated, non-technological factors, such as changes in level of capacity utilization and changes in the composition of production, may influence the course of productivity. It may, perhaps, be considered a defect of available statistics that they do not permit us to construct measures which would reveal only changes which are of a permanent character. Capricious fluctuations in productivity resulting from changes in capacity utilization are of an impermanent character and reflect no change in the state of production techniques.

It is important also not to overlook the fact that, whatever the reason for a change in the productivity level of an industry, the index is an average and subject to the limitations of all averages. Thus, an industry index should not be expected to depict the change occurring in any particular plant or branch of an industry. The mere shifting of production from plants at one level of productivity to plants at another may affect the average level for an industry as a whole.

It is frequently assumed that rising productivity necessarily implies labor displacement. Though it sometimes does involve direct labor displacement, it may also have less drastic and more subtle implications. Indeed, it may even go hand in hand with rising employment, as

it has in the rayon industry during the 1930's and as it has during the expansive phases of most, if not all, other manufacturing industries.

There is a fundamental difference between production *per se* and production as implied in a productivity index that is frequently overlooked. In many production indexes, final output is the only matter of interest. In connection with productivity, on the other hand, production is understood to imply the movement of specified materials through a given series of manufacturing operations. For example, a trend toward the purchase of semi-finished materials by an industry might properly be ignored in an index of final output. In a productivity index, on the other hand, a spurious increase, unrelated to any actual technological change, might result from such a trend, unless appropriate allowance were made for it.

It may also be observed in passing that there is a fundamental assumption which is seldom explicitly recognized involved in the compilation of all the common productivity indexes. It is assumed that all human labor is interchangeable and additive, and that no more weight is to be attached to an hour of skilled labor than to an hour of unskilled labor in building up man-hour totals. A technological change which merely permits the substitution of lower- for higher-paid labor does not affect a productivity index.

From what has been said, it is clear that much unfinished business remains in the field of productivity indexes. Perhaps the major need is for unit-labor-requirements data covering a greater number of products. Such information, which is of intrinsic interest, is also essential to the construction of more satisfactory productivity indexes. The Bureau of Labor Statistics, through field studies, will continue to collect such data. It should be stressed that a substantial contribution to the available body of knowledge of labor requirements could be made by persons in industry or by investigators in the academic field. There has been in recent years a substantial improvement in both production and labor series with respect to adequacy of coverage and the degree of detail shown. A continuation of this trend will make possible the construction of more adequate productivity measures. It is evident from the discussion in this paper that improvements in the available materials will call forth the application of more refined statistical techniques.

MACHINE METHOD FOR THE EXTRACTION OF CUBE ROOT

By Otis E. Lancaster
University of Maryland

In a recent study of sequences defined by algebraic difference equations[1] the author found that a sequence of numbers defined by the recurrent relation

$$A_{n+1} = \left(\frac{A_n^3 + 2B}{A_n^3 + .5B}\right)\frac{A_n}{2} \tag{1}$$

converges very rapidly to the cube root of B. That is, if A_1 is an approximation to the cube root of B, then

$$A_2 = \left(\frac{A_1^3 + 2B}{A_1^3 + .5B}\right)\cdot\frac{A_1}{2}$$

is a better approximation;

$$A_3 = \left(\frac{A_2^3 + 2B}{A_2^3 + .5B}\right)\cdot\frac{A_2}{2}$$

is a still better approximation; etc. These numbers approximate to the cube root of B much more rapidly than the corresponding numbers defined by the algorithm,

$$A_{n+1} = \frac{B/A_n^2 + 2A_n}{3}, \tag{2}$$

which is the basis of the present machine method of calculation. If two consecutive numbers A_n and A_{n+1} of a sequence defined by (1) agree in the first i digits, then A_{n+1} is correct to $3i-2$ digits. Whereas if two consecutive numbers of a sequence defined by (2) agree in the first i digits, then the second number is correct to $2i-1$ digits.

It is the purpose of this paper to outline a procedure to use on a calculating machine.[2] The procedure given here is adapted to a ten place Monroe calculating machine equipped with automatic division and semi-automatic multiplication (use of plus and minus bars). Some variations in technique may be necessary if other calculating machines, or even other Monroe models, are to be used.[3]

[1] "Sequences Defined by non-linear Algebraic Difference Equations," *Annals of Mathematics*, Vol. 42, 1941, pp. 251–280.

[2] This is published with special permission of the Monroe Calculating Machine Company.

[3] The author desires to express his thanks to Mr. Fred C. Diedrich for his suggestions.

First, commence at the decimal point and mark the number off into periods of three digits each. Shift the decimal point of the number so that it lies between the digits of the first and second period. (The decimal point of the answer can then be placed in the proper place after the calculation is completed.) Use the following decimal set-up

upper-dials	7
keyboard	7
lower-dials	14.

First Approximation. Mentally approximate the root. Call this value A_1. Particular care need not be used in obtaining this estimate. However, the closer the approximation, the fewer operations needed.

Second Approximation. 1. Set A_1 on the keyboard and multiply by A_1. Copy the result on the keyboard (depress minus bar to prove correct transfer). Clear dials and multiply by A_1 to produce the cube of the approximation.

2. Set the base number, B, on the keyboard. Multiply by .5000000. Mentally note the sum of the products (numbers on lower dials). Clear upper dials only.

3. With base number still on the keyboard multiply by 1.5000000 to produce numerator in formula. Clear upper dials and keyboard.

4. Set sum mentally noted in step 2 on keyboard.[4] Line up carriage for division and push division lever. Clear keyboard and lower dials.

5. Set A_1 on the keyboard and return upper dials to zero with plus bar. Enter 2.0000000 on the keyboard and push division lever. The second approximation appears in upper dials. Clear lower dials and keyboard. Record A_2.

Third Approximation. 1. Set the first three digits of A_2 on the keyboard and return the first three digits (on left) of upper dials to zero with plus bar. Copy result in lower dials on keyboard and depress minus bar to prove correct transfer. Multiply amount on keyboard by the first three digits of A_2. Clear upper dials and keyboard.

Continue as in other steps of Second Approximation.

If A_3 and A_2 agree in the first three digits, then the first seven digits of A_3 are correct. (Note this does not mean that the result is correct to seven digits for the machine does not round the numbers and the 8th digit may be 5 or more. Moreover, it may be incorrect.) If A_3 and A_2 agree in the first two digits, then the first 4 digits of A_3 are correct. If one's first approximation is the nearest half integer, the third approximation is correct to the first seven digits. No more correct digits can

[4] If this sum contains four digits to left of the decimal point, shift the decimal point on the keyboard one place to the right for the two operations in steps 4 and 5.

be assured with the above decimal set up. (By a modification, the method may be used to obtain the first nine correct digits.)

EXAMPLE

Consider the example given in Monroe's pamphlet on "Machine Methods for the Extraction of Cube and Other Roots."

$$\sqrt[3]{128.53}$$

First approximation, let $A_1 = 5.0000000$.

Second Approximation. 1. Set 5.0000000 on the keyboard and multiply by 5.0000000. Copy result in the lower dials on the keyboard and depress the minus bar to prove the correct transfer. Clear the upper dials. Multiply the amount on the keyboard by 5.0000000 to produce the cube of the approximation. Clear the upper dials and the keyboard.

2. Set the base number 128.53 on the keyboard and multiply by .5000000. Mentally note the sum of the products, 189.265. Clear upper dials only.

3. With the base number still on the keyboard multiply by 1.5000000. Clear the upper dials and the keyboard.

4. Enter the number noted mentally in step 2 on the keyboard. Line up carriage for division and push the division lever. (The result is 2.0186510.) Clear the keyboard and the lower dials.

5. Set the approximation 5.0000000 on the keyboard and return upper dials to zero with plus bar. Set 2.0000000 on the keyboard and push the division lever. The second approximation, 5.0466275, appears in the upper dials. Record this result. Clear the lower dials and the keyboard.

Third Approximation. 1. Set 5.04 on the keyboard and return the first three digits (5.04) of the upper dials to zero with the plus bar. Copy the result in the lower dials on the keyboard and depress minus bar to prove the correct transfer. Clear the upper dials. Multiply the amount on the keyboard by 5.04. Clear the upper dials and the keyboard.

2. Set the base number, 128.53, on the keyboard and multiply by .5000000. Mentally note the result (192.289064). Clear the upper dials.

3. With the base number still on the keyboard, multiply by 1.5000000. Clear the upper dials and the keyboard.

4. Enter the number 192.289064 mentally noted in step 2 on the keyboard. Push the division lever. Clear lower dials and keyboard.

5. Set 5.04 on the keyboard and return the upper dials to zero with the plus bar. Clear the keyboard. Set 2.0000000 on the keyboard and push the division lever. The third approximation 5.0466303 appears in the upper dials. Since the first three digits are the same as 5.04, the

result is correct for the first seven digits. Since occasionally one makes an error in the use of the machine the result should be checked.

The advantage of this method over the old method is more readily illustrated by examples which are not so nearly equal to a perfect cube.

A similar rule for obtaining other roots, based on the general relation

$$A_{n+1} = \left(\frac{(p-1)A_n{}^p + (p+1)B}{(p+1)A_n{}^p + (p-1)B} \right) \cdot A_n$$

could be given. This formula becomes

$$A_{n+1} = \left(\frac{A_n{}^p + \dfrac{p+1}{p-1} B}{A_n{}^p + \dfrac{p-1}{p+1} B} \right) \cdot \left(\frac{p-1}{p+1} \right) \cdot A_n,$$

when it is written in an analogous way to the formula for cube root. However, the author does not deem it applicable at present.

JAMES WATERMAN GLOVER, 1868–1941

The death of James W. Glover on July 15, 1941, was the end of the career of a man who contributed as much to the development of instruction in the mathematics of finance, actuarial science, and mathematical statistics in American universities as any other individual.

He was a member of the Mathematics Department of the University of Michigan from 1895 to 1938, the date of his retirement, becoming a full professor in 1911 and later serving as chairman of his department. In 1902 he began instruction in the mathematics of finance and insurance and under his direction there soon developed the broad and sound curriculum in actuarial science for which Michigan became noted. For many years the annual examinations of the American actuarial societies have been given in Ann Arbor. He was one of the first in America to forsee the coming importance of mathematical statistics and very soon after the beginning in actuarial science, instruction in the related but broader subject was begun. Professor H. C. Carver joined the staff in 1916, and he was actively encouraged by Professor Glover to develop the work in mathematical statistics which has since come to occupy so prominent a place at the University of Michigan and which has added to its reputation. An early feature of instruction in these two subjects was the provision of calculating machines for the use of all the students; in particular, when Angell Hall was built in 1925, Professor Glover took the opportunity to include in it statistical laboratories equipped in a way unique at that time. Excellent libraries in these two fields were built up. As an administrator Professor Glover was successful, not only strengthening the staff in the subjects he was most directly concerned with, but also in a notable way in pure mathematics.

Professor Glover's own work was largely in actuarial science and population statistics. As early as 1896 he was consultant to the Canadian Royal Commission on Insurance. In 1906 and 1907 he was consulting actuary to the Wisconsin Legislative Committee and to the Joint Committee on Banks and Insurance. These were typical of a long career as an insurance and statistical expert for many public and private agencies. One must mention his long association with the U. S. Census Bureau, his special service to his University and his state with respect to the setting up of pension funds, and his extended participation in the affairs of the Teachers Insurance and Annuity Association which he served as president during the two years, 1930–1932.

In addition to many articles, his longer published works include the especially noteworthy *U. S. Life Tables for 1890, 1901, 1910,* and *1901–10* (Government Printing Office), the widely used *Tables of Applied Mathematics in Finance, Insurance and Statistics* (George Wahr, Ann Arbor, 1923), and the *Mathematics of Life Insurance* (with W. O. Menge) (Macmillan, 1935).

He was long a member of the American Statistical Association and was elected a Fellow about 1917.

CECIL C. CRAIG

PROCEEDINGS

103RD ANNUAL MEETING

BILTMORE HOTEL, NEW YORK

PROGRAM

Saturday, December 27, 1941

—10:00 A.M.—

STATISTICAL EXAMINATION OF INVESTMENT EXPERIENCE

Chairman: Donald B. Woodward, Mutual Life Insurance Company of New York

Statistical Examination of Mortgage Experience

Part 1. Lawrence N. Bloomberg, United States Housing Authority

Part 2. Mortimer Kaplan, Federal Housing Administration

Discussion: Frank J. Travers, Lincoln National Life Insurance Company

Clifford C. Boyd, Federal Home Loan Bank Board

Statistical Examination of Corporate Bond Experience

Harold G. Fraine, Securities and Exchange Commission

Discussion: O. Paul Decker, American National Bank and Trust Company

Research in Municipal Finance

Harry L. Severson, Federal Deposit Insurance Corporation

Discussion: Susan S. Burr, Board of Governors of the Federal Reserve System

Sanders Shanks, Jr., *The Bond Buyer*

C. A. Sienkiewicz, Federal Reserve Bank of Philadelphia

ROLE OF A DIVISION OF RESEARCH AND STATISTICS IN AN ADMINISTRATIVE AGENCY

Chairman: F. Leslie Hayford, New York City

In a Business Organization

Henry B. Arthur, Swift & Company

In the Field of Relief and Social Work

Robert T. Lansdale, Community Service Society

In the Federal Government

Woodlief Thomas, Board of Governors of the Federal Reserve System

Discussion: Donald Belcher, American Telephone and Telegraph Company

Ewan Clague, Social Security Board

Saturday, December 27, 1941

—10:00 A.M.—

IMPACT OF DEFENSE ON SPECIAL ECONOMIC AREAS

Chairman: Theodore O. Yntema, University of Chicago and Cowles Commission

Impact of War upon Industrial Capacity and Investment
M. Joseph Meehan, Bureau of Foreign and Domestic Commerce

Impact of Defense on Labor Supply and Labor Utilization
Louis Levine, Social Security Board

EFFECTS OF A RELATIVELY STATIONARY POPULATION TOTAL

Round Table

Chairman: Edmund deS. Brunner, Teachers College, Columbia University

Discussion: Richard M. Bissell, Jr., Harvard University
Louis I. Dublin, Metropolitan Life Insurance Company
Frank W. Notestein, Princeton University
Leon E. Truesdell, Bureau of the Census
Clyde V. Kiser, Milbank Memorial Fund
Frank Lorimer, American University
P. K. Whelpton, Scripps Foundation for Research in Population Problems
Alan Sweezy, Williams College
O. E. Baker, Bureau of Agricultural Economics

—2:30 P.M.—

ROLE OF TESTS OF SIGNIFICANCE IN BIOLOGICAL RESEARCH

(Biometrics Section with the Institute of Mathematical Statistics)

Round Table

Chairman: Edwin B. Wilson, School of Public Health, Harvard University

Discussion: W. Edwards Deming, Bureau of the Census
Harold Hotelling, Columbia University
Lowell J. Reed, Johns Hopkins University School of Hygiene and Public Health
George W. Snedecor, Iowa State College

SELECTED PROBLEMS IN FISCAL POLICY

(With the American Economic Association)

Chairman: W. L. Crum, Harvard University

The Theory of Public Investment
Seymour E. Harris, Harvard University

The Capital Budget Idea in the Light of the Defense Program
Morris A. Copeland, Office of Production Management

Accounting for Public Investment
George O. May, Price, Waterhouse & Company

Discussion: Dan T. Smith, Harvard University
Rufus S. Tucker, General Motors Corporation

Saturday, December 27, 1941

—2:30 P.M.—

STATISTICS IN RELIEF ADMINISTRATION

(Arranged by the Joint Committee on Relief Statistics)

Chairman: Ralph G. Hurlin, Russell Sage Foundation

Measurement of the Effect of Defense Employment on Relief Loads
Walter Perkins, Social Security Board
Validity of Estimates of Employability of Relief Recipients
Robert P. Wray, Pennsylvania Department of Public Assistance
Measurements of the Normality of Relief Populations
Raymond Willoughby, Rhode Island Department of Social Welfare
Discussion: Emmett H. Welch, Bureau of Labor Statistics
Irma Rittenhouse, New York State Department of Labor

THE USE OF CENSUS DATA IN ANALYZING MARKETING PROBLEMS

(With the American Marketing Association)

Chairman: Vergil D. Reed, Bureau of the Census

Small Area Census Data and Their Use in Marketing Analysis
Alfred N. Watson, Curtis Publishing Company
Recent Changes in Food Marketing as Revealed by the Census
Carl W. Dipman, *The Progressive Grocer*
Recent Changes in Industrial Markets Revealed by the Census
Lowell J. Chawner, Bureau of Foreign and Domestic Commerce
Discussion: Paul Nystrom, Columbia University

ROLE OF A DIVISION OF RESEARCH AND STATISTICS IN AN ADMINISTRATIVE AGENCY

Round Table

Chairman: Meredith B. Givens, New York State Department of Labor

—8:00 P.M.—

CRITERIA IN ESTABLISHING PRICES BY THE GOVERNMENT

(With the American Farm Economic Association)

Chairman: Frederick C. Mills, Columbia University

Criteria in Establishing Farm Prices
Warren Waite, University of Minnesota
Criteria in Establishing Non-Agricultural Prices
Donald Wallace, Office of Price Administration
Discussion: Clayton Gehman, Board of Governors of the Federal Reserve System
Sidney Hoos, Commodity Credit Corporation

Saturday, December 27, 1941

—8:00 P.M.—

CONTRIBUTED PAPERS BY YOUNGER MEMBERS

Chairman: W. L. Crum, Harvard University

Selective Service's Medical Statistics Program
Oliver H. Folk, Selective Service System

Conspicuous Consumption as Measured by Clothing Expenditures
A. J. Jaffe, Bureau of the Census

The Method of Classifying Areas with Respect to Housing Characteristics
Berenice B. Lapin, Office of Defense Housing Coordinator

Gross and Net Unemployment: The Importance of Definition in the Measurement of Unemployment
Clarence D. Long, Jr., The Institute for Advanced Study

The Limitations of Tests of Significance for Index Numbers of Prices
Nilan Norris, Hunter College

A Critical Appraisal of Business Statistics
John S. Perkins, Boston University

Sunday, December 28, 1941

—9:00 A.M.—

BREAKFAST MEETING—OFFICERS, DIRECTORS, AND DISTRICT REPRESENTATIVES

—10:00 A.M.—

NEW METHODS OF NUMERICAL CALCULATION

I. Statistical and Matrix Calculation
(With the Institute of Mathematical Statistics, and with the cooperation of the Committee on Addresses in Applied Mathematics of the American Mathematical Society)
Technical Session

Chairman: Charles R. Langmuir, Carnegie Foundation for the Advancement of Teaching

Some New Matrix Methods in Least Square and Other Multivariate Problems
Harold Hotelling, Columbia University

The Mallock Electrical Calculating Machine for Solving Simultaneous Linear Equations
Elizabeth Monroe Boggs, Cornell University

Mathematical Operations with Punched Cards
J. C. McPherson, International Business Machines Corporation

Recent Developments in Correlation Technique
Paul S. Dwyer, University of Michigan

Sunday, December 28, 1941

—2:30 P.M.—

CONTRIBUTED PAPERS I

(Arranged by the Biometrics Section)

Chairman: Hugo Muench, Rockefeller Foundation

Energy at the Threshold of Vision
Selig Hecht, Columbia University

Some Aspects of the Multiple Hit Problem
C. P. Winsor and J. W. Tukey, Princeton University

Biologic Analysis in Allergy
Margaret R. Pabst, Work Projects Administration

Environment Effects on Sex Ratio, Malformations and Habitus of the Newborn
W. F. Peterson, University of Illinois Medical School, and Alvin Mayne, Office of Production Management

PERSONNEL SELECTION AND VOCATIONAL GUIDANCE

Chairman: Harry A. Jager, U. S. Office of Education

Validating Employment Tests
C. L. Shartle, Social Security Board

Personnel Selection in the Public Service
Albert H. Aronson, Social Security Board

A Study of Vocational Adjustment of Metropolitan Youth
Irving Lorge, Teachers College, Columbia University

Discussion: Albert K. Kurtz, Life Insurance Sales Research Bureau

NEW METHODS OF NUMERICAL CALCULATION

II. Mechanical Solution of Differential Equations

(With the Institute of Mathematical Statistics, and with the cooperation of the Committee on Addresses in Applied Mathematics of the American Mathematical Society)

Technical Session

Chairman: Ronald M. Foster, Bell Telephone Laboratories

Punch-card Calculation of Orbits
W. J. Eckert, Naval Observatory

Punch-card Methods for Solving Linear Differential Equations of Second Order
Martin Schwarzschild, Columbia University

Differential Analyzers
S. H. Caldwell, Massachusetts Institute of Technology

Discussion: L. S. Dederick, Aberdeen Proving Ground
Norbert Wiener, Massachusetts Institute of Technology

Sunday, December 28, 1941

—2:30 P.M.—

CONSUMER PREFERENCE STUDIES

(With the American Marketing Association)

Chairman: Lawrence C. Lockley, Curtis Publishing Company

Psychological Difficulties in Measuring Consumer Preferences
Albert Blankenship, N. W. Ayer & Son
Sales Tests as a Method of Product Testing
Ross Cunningham, Massachusetts Institute of Technology
Pre-Testing of Products by Consumer Juries
Marie Sellers, General Foods Corporation
Reaction of Farmers to Agricultural Programs
Rensis Likert, Department of Agriculture
Techniques of Appraising Brand Preference by Consumer Interviewing
Harry D. Wolfe, Kent State University
Discussion: Ralph Cassady, Jr., University of California
Oliver F. Benz, DuPont Company

WAGES, PRICES, RENTS, AND DEFENSE

Chairman: Aryness Joy, Bureau of Labor Statistics

Measurement of Wage Differentials in Manufacturing Industries
Robert Myers, Bureau of Labor Statistics
The Problems of Determining Fair Rents
Karl Borders, Office of Price Administration
Prices and Wages—Recent Trends
Walter J. Keim, Bureau of Labor Statistics

—6:30 P.M.—

DINNER MEETING OF THE BIOMETRICS SECTION, FOLLOWED BY THE BUSINESS MEETING OF THE SECTION

—8:00 P.M.—

THE CHANGING POSITION OF THE BANKING SYSTEM AND ITS IMPLICATIONS FOR MONETARY POLICY

(With the American Economic Association)

Chairman: Oliver M. W. Sprague, Harvard University

The Implications of Fiscal Policy for Banking and for Monetary Control
John H. Williams, Harvard University
The Future of Commercial Banking
Murray Shields, Irving Trust Company
The Future of the Government Loan Agencies
Neil H. Jacoby, University of Chicago

Sunday, December 28, 1941

—8:00 P.M.—

ON SOME TECHNICAL ASPECTS OF SAMPLING

(With the Institute of Mathematical Statistics)

Technical Session

Chairman: Helen M. Walker, Teachers College, Columbia University

On the Relative Efficiencies of Various Areal Sampling Units in Population Inquiries

Morris H. Hansen and William Hurwitz, Bureau of the Census

On the Monthly Sample Survey of Unemployment

Lester R. Frankel and J. Stevens Stock, Work Projects Administration

On Certain Biases in Samples of Human Populations

J. Cornfield, Bureau of Labor Statistics

On the Relation of Probability to Sampling

William G. Madow, Bureau of the Census

Recent Developments in Sampling for Agricultural Statistics

George W. Snedecor and Arnold J. King, Iowa State College

Discussion: William G. Cochran, Iowa State College
Joseph A. Greenwood, Duke University
Meyer A. Girshick, Bureau of Agricultural Economics

Monday, December 29, 1941

—9:00 A.M.—

ANNUAL BUSINESS MEETING. Reports and Election of Officers

—10:00 A.M.—

MEASURING NATIONAL DEFENSE

Chairman: Henry B. Arthur, Swift & Company

Measuring National Income as Affected by the War

Milton Gilbert, Bureau of Foreign and Domestic Commerce

Measuring Economic Burdens of Defense in Various Nations

Raymond Goldsmith, Securities and Exchange Commission

Measuring Defense Progress

Lester Kellogg, Office of Production Management

SAVINGS AND INVESTMENTS AND THE EMERGENCY

(With the American Finance Association)

Chairman: C. O. Hardy, Brookings Institution

National Income, Savings, and Investments Since 1880

Simon Kuznets, National Bureau of Economic Research

Savings and Investments as Reflected in Corporation Reports

Rexford C. Parmelee and Irwin Friend, Securities and Exchange Commission

Discussion: Claude L. Benner, Continental American Life Insurance Company
George Terborgh, Machinery and Allied Products Institute
Richard V. Gilbert, Office of Price Administration

Monday, December 29, 1941

—10:00 A.M.—

SOCIAL WELFARE STATISTICS

Technical Session

Chairman: Anne E. Geddes, Social Security Board

The Use and Value of Statistics of Group Work
Arthur L. Swift, Union Theological Seminary
The Importance of Hospital Morbidity Data for the Community
Marta Fraenkel, Welfare Council of New York City
Some New Facts Relating to Old-Age and Survivors Insurance Beneficiaries
Margaret Stecker, Social Security Board
The Problem of Measurement of Volume and Cost of the Public Social Services in the United States
Marjorie Shearon, U. S. Public Health Service

WHAT CAN THE CENSUS DO WITH SAMPLING?

(With the Institute of Mathematical Statistics)

Chairman: L. Edwin Smart, Ohio State University

An Appraisal of the 1940 Sampling Scheme—Did It Work Out the Way It Was Expected To?
Theodore O. Yntema, University of Chicago and Cowles Commission, and Dickson H. Leavens, Cowles Commission
Some Requirements of Sampling Design and Presentation
W. Edwards Deming, Bureau of the Census
Compromises, Losses, and Gains Brought About by the Introduction of Sampling
Leon E. Truesdell, Bureau of the Census
The Proposed Annual Sample Census
Philip M. Hauser, Bureau of the Census
Discussion: Alfred N. Watson, Curtis Publishing Company
Samuel A. Stouffer, University of Chicago

CONTRIBUTED PAPERS II

(Arranged by the Biometrics Section)

Chairman: George W. Snedecor, Iowa State College

Some Statistical Problems Concerned in the Formulation of Egg Yield Standards
Willard C. Thompson, New Jersey Agricultural Experiment Station
Variation in Binominal Series Observed in the Survival of Mosquito Larvae at Different Salt Concentrations
Hugo Muench, Rockefeller Foundation
The Effect of the Full Moon on Trout Fishing
C. McC. Mottley and Daniel R. Embody, Cornell University
Tests of Significance Considered as Evidence
Joseph Berkson, Mayo Clinic

Monday, December 29, 1941

—12:30 P.M.—

LUNCHEON MEETING—CENSUS TRACT CONFERENCE
(Arranged by the Committee on Census Enumeration Areas)
Chairman: Howard Whipple Green, Cleveland Health Council
The Census Tract Report for Providence
Leon E. Truesdell, Bureau of the Census
Distribution of the Report to Get Maximum Use
Howard Whipple Green, Cleveland Health Council

—2:30 P.M.—

CENSUS TRACT CONFERENCE
(Arranged by the Committee on Census Enumeration Areas)
Chairman: Howard Whipple Green, Cleveland Health Council
The Local Preparation of a Supplemental Report
Howard Whipple Green, Cleveland Health Council
How to Use the New Block Data
Ernest M. Fisher, American Bankers Association
Business Uses of Data by Census Tracts and Blocks
Vergil D. Reed, Bureau of the Census
Census Tracts—Their Future
C. E. Batschelet, Bureau of the Census

THE WORK OF THE TEMPORARY NATIONAL ECONOMIC COMMITTEE
(With the American Economic Association)
Chairman: Willard L. Thorp, Associated Gas and Electric Company
The Studies of Saving and Investment
Moses Abramovitz, National Bureau of Economic Research
Price and Production Policies
Mandell M. Bober, Lawrence College
Large and Small Business and the Concentration of Production
George J. Stigler, University of Minnesota
Discussion: Fritz Machlup, University of Buffalo
John Perry Miller, Yale University
Ralph C. Epstein, University of Buffalo

LABOR SUPPLY, EMPLOYMENT AND MIGRATION
(With the American Association for Labor Legislation)
Chairman: William A. Berridge, Metropolitan Life Insurance Company
Recent Labor Market Developments and the Defense Program
Collis Stocking, Social Security Board
The Meaning of Productivity Indexes
W. D. Evans, Bureau of Labor Statistics
Estimating Labor Requirements
Donald H. Davenport, Bureau of Labor Statistics
Defense Migration and Labor Supply
Howard Myers, Work Projects Administration

Monday, December 29, 1941

—2:30 P.M.—

PROBLEMS OF PRICE CONTROL

(With the American Economic Association)

Round Table

Chairman: Don D. Humphrey, Office of Price Administration

EXPERIMENTS ON INSECT CONTROL, THEIR DESIGN AND ANALYSIS

(Arranged by the Biometrics Section with the cooperation of the American Association of Economic Entomologists, Eastern Branch)

Chairman: F. Z. Hartzell, New York Agricultural Experiment Station

Comparison of the Toxicity to Aphis rumicis *of Certain Organic Compounds*
William Moore, American Cyanamid Company

Effect of Variable Copper-lime Bordeaux Ratios in Flea Beetle Control
W. A. Rawlins, Cornell University

Relation of Corn-borer Biology to Field Plot Technique
Neely Turner, Connecticut Agricultural Experiment Station

Plot Design and the Combination of Observations in Insecticidal Experiments on the Codling Moth
H. N. Worthley, Pennsylvania State College

—8:00 P.M.—

CLINIC ON ENTOMOLOGICAL PROBLEMS

(Arranged by the Biometrics Section with the cooperation of the American Association of Economic Entomologists, Eastern Branch)

Chairman: Roger B. Friend, Connecticut Agricultural Experiment Station

Special Plot Techniques Used in Investigations of Fruit Insects
F. Z. Hartzell, New York State Agricultural Experiment Station

Informal presentation of problems in applied entomology for joint discussion by statisticians and entomologists

—8:30 P.M.—

PRESIDENTIAL ADDRESSES

(With the American Economic Association)

Chairman: Frederick C. Mills, Columbia University

The Conditions of Expansion
Sumner H. Slichter, Harvard University, President of the American Economic Association

Government and the Statistician
Winfield W. Riefler, Institute for Advanced Study, President of the American Statistical Association

Tuesday, December 30, 1941

—8:00 A.M.—

BREAKFAST MEETING—OFFICERS AND DIRECTORS

—10:00 A.M.—

DIFFERENTIAL PRICING AND THE GENERAL WELFARE

(With the American Marketing Association)

Chairman: Edwin G. Nourse, Brookings Institution

Types of Differential Pricing

Corwin Edwards, Department of Justice

Examples in Various Industries:

Public Utilities

Burton N. Behling, Interstate Commerce Commission

Milk

E. E. Vial, Surplus Marketing Administration

Agricultural Surplus Programs

A. C. Hoffman, Office of Price Administration

Social Appraisal of Differential Pricing

Morris A. Copeland, Office of Production Management

Discussion: Fritz Machlup, University of Buffalo

THE USE OF 1940 CENSUS DATA BY FINANCIAL INSTITUTIONS

Chairman: Arthur E. Weimer, School of Business, Indiana University

The Use by Financial Institutions of Data from the Population and Housing Census of 1940

David L. Wickens, Consulting Economist

Discussion: Howard G. Brunsman, Bureau of the Census
Joseph Demmary, University of Washington

The Use by Financial Institutions of Data from the Agricultural Census of 1940

Donald C. Horton, Department of Agriculture

Discussion: A. G. Brown, American Bankers Association
Ralph C. Limber, Farm Mortgage Conference of Life Insurance Companies
Norman J. Wall, Department of Agriculture

ANIMAL GROWTH

(Arranged by the Biometrics Section)

Chairman: Antonio Ciocco, U. S. Public Health Service

Determination of the Age of Deer by Means of the Discriminant Function

Besse B. Day and Marion M. Sandomire, Department of Agriculture

Effect of Protein-Mineral-Vitamin Supplements to Barley upon the Growth Rate of Hogs

D. B. DeLury, University of Toronto, and E. W. Crampton, Macdonald College

Analysis of the Relative Growth of Organisms

O. W. Richards and A. J. Kavanagh, Spencer Lens Company

New Formulations in the Study of Rat Growth

T. F. Zucker and Lois Zucker, Columbia University College of Physicians and Surgeons

Tuesday, December 30, 1941

—10:00 A.M.—

RECENT ADVANCES IN MATHEMATICAL STATISTICS

(With the Institute of Mathematical Statistics and the Econometric Society)

Chairman: Harold Hotelling, Columbia University

Recent Advances in Mathematical Statistics

I. Burton H. Camp, Wesleyan University

II. Cecil C. Craig, University of Michigan

HOW SHALL AMERICAN LABOR'S STANDARDS AND SECURITY BE SAFEGUARDED NOW AND DURING THE POST-WAR EMERGENCY?

(With the American Association for Labor Legislation)

Round Table

Chairman: J. Douglas Brown, Office of Production Management

Discussion: Arthur J. Altmeyer, Social Security Board
Ewan Clague, Social Security Board
Herman Feldman, College of the City of New York
Clinton S. Golden, Steel Workers Organizing Committee
Marion Hedges, International Brotherhood of Electrical Workers
Frank Herring, National Resources Planning Board
Lewis L. Lorwin, National Resources Planning Board
W. H. Winans, Union Carbide and Carbon Company

—12:30 P.M.—

LUNCHEON MEETING—THE ECONOMIC OUTLOOK, 1942

Chairman: Winfield W. Riefler, President of the American Statistical Association

The Task of Industry in 1942

Donaldson Brown, General Motors Corporation

The Prospect for 1942

W. Randolph Burgess, National City Bank of New York

—2:30 P.M.—

EXPERIMENTAL DESIGN IN RELATION TO SAMPLING

(Biometrics Section with the Institute of Mathematical Statistics)

Boyce Thompson Institute, Yonkers, N. Y.

Chairman: W. J. Youden, Boyce Thompson Institute

Biological Interpretation of Interactions

W. C. Jacobs, Cornell University

Adapting the Design to the Experiment

G. M. Cox, North Carolina State College

Sampling Theory When the Sampling Units Are of Unequal Size

W. G. Cochran, Iowa State College

Sampling Errors of Systematic and Random Surveys of Cover Type Areas

J. G. Osborne, Forest Service

Various experimental designs on display in the greenhouses of the Institute before and after the session

Minutes of the Annual Business Meeting

The American Statistical Association convened for the 103rd annual business meeting at 9:00 A.M., Monday, December 29, 1941, at the Biltmore Hotel in New York City. President Winfield W. Riefler presided.

The minutes of the 102nd annual business meeting were approved as published in the JOURNAL.[1]

The Secretary read the Annual Report of the Board of Directors.[2]

President Riefler announced the appointment of Lowell J. Reed to the Committee on Fellows for the period ending at the annual meeting in 1946. The report of the Committee on Fellows was read by its Chairman, F. Leslie Hayford. The Committee announced the election of the following Fellows: J. Frederic Dewhurst, George O. May, Vergil D. Reed, Bradford B. Smith, H. R. Tolley, and P. K. Whelpton.

The report of the Nominating Committee was presented by the Secretary. The Secretary reported that he had received no nominations by petition. It was voted to instruct the Secretary to cast one ballot for the candidates presented by the Nominating Committee. The ballot was cast and the following officers and directors were elected:

President: ALFRED J. LOTKA, Metropolitan Life Insurance Company

Vice-Presidents:

Collection and Classification of Data, and Administration of Statistical Agencies
CALVERT L. DEDRICK, Bureau of the Census

Statistical and Actuarial Methods and Technique, and the Teaching of Statistics
WALTER BARTKY, University of Chicago

Facts and Methods Pertaining to Sociology, Social Welfare Problems, and Labor Statistics
HOWARD B. MYERS, Work Projects Administration

Facts and Methods Related to Biometry, Vital Statistics, Psychology, and Education
FRANK W. NOTESTEIN, Office of Population Research, Princeton University

Facts and Methods Bearing upon Economics and Economic Theory
NORMAN J. SILBERLING, Stanford University

Facts and Methods Pertaining Primarily to Business
HENRY B. ARTHUR, Swift & Company

Facts and Methods Pertaining to Financial Institutions
HAROLD V. ROELSE, Federal Reserve Bank of New York

Facts and Methods Pertaining to Marketing
ALFRED N. WATSON, Curtis Publishing Company

Directors: (For the terms expiring at the Annual Meeting in 1944)

WINFIELD W. RIEFLER, Institute for Advanced Study
WALTER A. SHEWHART, Bell Telephone Laboratories

[1] This JOURNAL, 36 (March, 1941) 131.
[2] This JOURNAL, pp. 131-35.

Secretary-Treasurer: RICHARD L. FUNKHOUSER, American Statistical Association

The President presented the recommendations of the Board of Directors for amendments to the Constitution. During the discussion one modification was suggested in the proposal offered by the Board of Directors. It was voted that Articles V, VI, VII and VIII of the Constitution be amended to read as follows:

Article V—Officers

The officers of the Association shall be a Chairman of the Board, a President, a number of Vice-Presidents, a Secretary, a Treasurer, and an Editor. The duties of the officers shall be those usually devolving upon such officers except as may be otherwise provided by the By-Laws.

Each of the Vice-Presidents shall represent a distinct field of statistical interest. The number and fields of interest of the several Vice-Presidential offices shall be fixed in accord with the provisions of the By-Laws. The Vice-Presidents shall assist and advise in the preparation for annual and special meetings and in other matters concerning the interests of the groups they respectively represent in the membership of the Association. In case of the incapacity of the Chairman of the Board to perform the duties of his office on any occasion the President shall act as Chairman of the Board.

Article VI—Board of Directors

There shall be a Board of Directors for the government of the Association consisting of the Chairman of the Board, the President, the Secretary and six elected Directors. The Secretary shall call a meeting of the Board of Directors on the request of the Chairman of the Board, the President, or any three Directors and shall notify the Directors of such meetings at least seven days in advance. Three Directors shall constitute a quorum at any meeting regularly convened.

Article VII—Elections

The officers of the Association other than the Chairman of the Board and the Editor shall be elected each year at the Annual Meeting and shall serve until the close of the Annual Meeting at which their successors are elected. Upon the expiration of his term of office, the President shall become the Chairman of the Board for a term of one year. The Editor shall be appointed by the Board of Directors. The six elected Directors shall be elected for terms of three years each, two of which terms shall expire at the close of each Annual Meeting. No elected Director may serve two terms in immediate succession. The Board of Directors shall fill vacancies in any office and in its own membership until the next Annual Meeting.

The President shall appoint a Nominating Committee of three members, the personnel of which shall be announced to the membership at least three months before the Annual Meeting. At least thirty days before the Annual Meeting the Nominating Committee shall report to the membership its nominations of officers and Directors to be elected at the next Annual Meeting.

Twelve or more Regular Members or Fellows may make nominations for any office by submitting a signed petition to the Secretary of the Association not less than twenty-four hours before the beginning of the business meeting at which the election is scheduled to take place. In case a nomination by petition is made, the Nominating Committee may present to the Annual Meeting the names of one or more additional nominees for the same office.

When but one person has been nominated for a given office, that person may be elected at the Annual Meeting by a viva voce vote. If there are two or more nominations for the same office, it shall be the duty of the Secretary to announce such nominations. In the latter case, the election for this office shall be by secret ballot, and the Chairman of the Board shall appoint three judges of election who shall count the ballots. The judges of election shall decide any questions that may arise as to the validity of any ballot, and shall declare the results of

the election. The candidate who receives a plurality of the votes cast for that office shall be declared elected. The Chairman of the Board shall vote only in case of a tie vote, in which event he shall cast the decisive ballot.

Article VIII—Meetings

Annual and occasional meetings of the Association shall be held at such times and places as the Board of Directors may designate. The Chairman of the Board shall have charge of the general program of such meetings with the assistance and advice of the Vice-Presidents, the Secretary, and the Section Committees.

Theodore H. Brown proposed two amendments to the By-Laws. It was voted to amend By-Law 4 to read as follows: "The field or fields of interest to be represented by each Vice-President shall be specified by the Board of Directors. The Nominating Committee shall make a nomination for each field of interest except that with the approval of the Board of Directors the Committee may nominate not more than eight Vice-Presidents by assigning to some of them responsibility for representing more than one field of interest." It was voted to amend By-Law 9 to read as follows: "These By-Laws may be amended at any Annual Meeting of the Association by a two-thirds vote of the members present and voting, or they may be amended through a mail ballot by a three-fourths vote of the members replying and voting."

The Secretary announced that the Annual Meeting of the Association in 1942 would probably be held in Cleveland, Ohio, and that the Annual Meeting in 1943 would probably be held in Chicago, Illinois.

The Secretary announced that the Association's headquarters office had been moved to the American University, Nebraska and Massachusetts Avenues, N.W., Washington, D. C.

The meeting was adjourned.

R. L. FUNKHOUSER, *Secretary*

Report of the Board of Directors

During the one hundred and two years since the founding of the American Statistical Association, our society has seen the Nation go through several periods of major warfare. As the current year draws to a close we observe the country embarking upon another armed conflict. We know little of what the years ahead may hold in store, but it is evident that our Association, like other institutions throughout the country and like the Nation itself, faces difficult times calling for courage and foresight.

During the first World War enormous stimulus was given to the development of more adequate and more reliable statistical information. The resulting impetus brought about the establishment of many of the existing current measurements of our social and economic life and laid the basis for more timely information than had been available hitherto. At present, as the Nation concentrates its energies and skills on the task of winning the War, we witness a further expansion of our statistical resources. Perhaps there has never been a time in which we are, as a Nation, more dependent upon reliable and timely information as a basis for sound policy and efficient administration.

During this period of transition from a defense to a war-time economy, the Association has maintained the essential functions that marked its program in the past, expanded its resources, and modified its program to meet changing conditions. The following review of the year's work bears witness to these developments.

Study of Defense Statistics: Your officers recognized the immense task encountered by the defense agencies in meeting the informational needs of the preparedness program. The Board of Directors requested the President to study the organization of statistical work of the Federal Government in an effort to appraise the problems of duplication, confusion, and inefficiency resulting from the expansion in the requirements for statistics by the defense agencies. Suggestions for the improvement of the statistical work relating to the defense program were offered informally on several occasions. Through its officers the Association is represented on a number of committees studying the statistical problems in more detail and preparing recommendations for their solution.

Encouragment is also being given to improvements in statistics in two realms closely connected to the defense program. One has to do with the existing information on the qualifications and skills of those composing the statistical profession. It is recognized that the efficiency and reliability of our statistics depend in large measure upon the effective use of competent statistical personnel. The second relates to the development of statistical indexes in more convenient and more comparable terms for the use of consumers of statistics. We have studied the possibilities of greater uniformity in the base periods of general-purpose indexes and surveyed the problems encountered in adopting a uniform base for their presentation.

Changes in Organization: During the year the Board of Directors and the officers continued to study the problems of organization of the Association and consulted with the Fellows and recent officers to get their reactions and suggestions. After careful deliberation it was decided to propose to the membership at this annual meeting that we make a number of changes in our organization in order to distribute more efficiently the responsibilities devolving upon the officers and to strengthen the preparation of the program for the annual meetings. The Directors also adopted a broad set of policies for their own guidance designed to stimulate the Association's Chapters and to encourage the organization of Sections for important subject-matter fields. We believe that it is important to keep the organization of the Association flexible in order to meet the changing conditions and to experiment with promising solutions to specific problems as they arise.

Committees: Committees of the Association have continued to render useful service to statisticians in several fields. The Census Advisory Committee held four meetings to review the program of the Sixteenth Decennial Census and to encourage greater emphasis on the analysis and interpretation of census data. The Committee considered the effect of the defense program on the activities of the Bureau and noted the resources for statistical services

that can be made available to defense agencies. It reviewed the proposals for a quinquennial census of industry and business and the collection of current business statistics; it discussed the proposals for a quinquennial census of population and housing combined with sample censuses in intervening years. The Committee advised in connection with the urgency of securing the funds necessary to bring the Sixteenth Decennial Census to a successful conclusion.

The Joint Committee on Relief Statistics held several meetings and rendered advice on a number of problems in the field of relief and welfare statistics. The Committee decided to resume the preparation of the *Bulletin of Information of Relief Statisticians* and arranged sessions at the annual meetings of the sponsoring societies. The Joint Committee on Occupational Classification met to develop policies on the tabulation of the occupational and industrial statistics of the Census of 1940. During the year three intermediate classification lists were prepared to be applied to areas where the complete detail could not be used; each is in harmony with the Convertibility List prepared by the Committee several years ago. A subcommittee is at work on the classification of new or changing occupational groups, with particular reference to titles peculiar to defense activities. The Committee on Census Enumeration Areas assisted in the plans for tabulations of census tract data and gave leadership to their wider use by statisticians. Members of the Joint Committee for the Development of Statistical Applications in Engineering and Manufacturing cooperated actively with many groups concerned with the application of statistical methods to defense problems in the field of industry. They also assisted in arranging scientific meetings and in the presentation of defense courses in statistical methods. The Joint Committee on Metropolitan Districts completed its task of recommending the Metropolitan Districts for a large number of densely populated areas and these were established as a part of the regular Sixteenth Decennial Census procedure. The Committee on Sampling was established during the year and promises to make an important contribution to the sound use of sample techniques in both private and governmental statistics.

Chapters: The Chapters of the Association maintained increasingly worthwhile activities in meeting the needs and interests of members in their respective areas. The Albany Chapter was responsible for the preparation of a printed index to existing information in the New York state government. A similar guide was prepared by the Harrisburg Chapter covering available data in Pennsylvania. Several of the Chapters are engaged in compiling directories of statisticians in their localities. These and similar enterprises supplemented the series of meetings arranged by most of the Association's Chapters. The Committee on Chapters has assisted in suggesting out-of-town speakers for a number of these meetings and has exerted leadership in the establishment of new Chapters. Chapters were launched in Montgomery, Alabama, and at the University of Illinois. There is evidence of growing interest in a dozen other centers in the establishment of local Chapters.

Biometrics Section: The Biometrics Section experienced an especially

fruitful year. Its membership, formerly composed almost entirely of professional statisticians, was doubled by enrolling biologists and similar specialists employing statistical techniques in their research. It arranged a number of scientific meetings with biological groups, in addition to the sessions with our Association and those organized by a special committee on the West Coast. Plans are under consideration for the near future calling for additional scientific meetings with biological societies, improvements in the organization of the Section, and other developments that will expand the usefulness of the Section's activities.

Publications: Four regular numbers of the JOURNAL were printed during the year. The first six issues of the expanded *Bulletin* were prepared. The Statistical News and Notes and the Chapter Activities, hitherto published in the JOURNAL, were transferred to the more frequent current issues of the *Bulletin*. The *Index to the Journal of the American Statistical Association*, covering the period from 1888 through 1939 and prepared last year, appeared early in the current year. A large number of copies were purchased by members and subscribers. The Association is grateful to the Rockefeller Foundation for making possible this important contribution to the usefulness of the JOURNAL. By action of the Board of Directors the net proceeds from the sale of the *Index* are being added to the Centenary Sustaining Fund.

Membership and Finances: Under authority of the amendment to By-Law 2 adopted last year, the Board of Directors established a special rate of dues of $3.00 for new members under 30 years of age during the first year of membership. In response to this action and the conscientious efforts of the Committee on Chapters and several local committees about 350 young statisticians joined the Association at the reduced rate. In addition nearly 275 statisticians and others interested in the Association's work became members at the regular rate of dues, bringing the total number of new members to more than 600. This produced a net increase in the membership during the year of about 350, so that at the end of the year our total membership is nearly 3,100.[1]

Largely as a result of this encouraging growth in membership our income from regular sources during 1941 was approximately $1,300 larger than the corresponding income a year ago. In addition, the sum of $2,500 was transferred from the Centenary Sustaining Fund to meet current operating expenses for the year.

It is difficult to forecast the effect of war conditions on the financial position of the Association during the period immediately ahead. However, your officers believe that with the further growth of statistical activity connected with the war effort we may expect a sustained growth in the Association's membership. We also anticipate increases in the expenses involved in maintaining our program. Some evidences of these increases in the expenses appeared during 1941 and if they become more severe and more rapid they may

[1] These estimates were superseded by figures compiled after the close of the year. See the Report of the Secretary, this JOURNAL, pp. 135-36.

require us to make some modifications in our plans. In order to effect economies that will not impinge seriously on our functions it was decided to move the Association's office to a new location furnished to us without expense through the generosity of the American University in Washington.

Responsibilities for the Future: In a period like the present there is an especial need for trustworthy and prompt statistical information, efficiently organized and accurately interpreted. The requirements relate not only to the defense industries but also the broader phases of our complex social and economic structure and its operation under rapidly changing conditions.

Consequently, while we must make adjustments in our Association's activities and plans as a result of the national emergency we need constantly to be on the alert to maintain a balanced program and to encourage lasting improvements in statistics and statistical methods. Moreover, as a professional society we should take part in preparing for the problems that will face the Nation in the period marked by a return to peace-time activities. These problems and the information that will be needed to cope with them will be no less urgent than those we face during the armed conflict. Our responsibilities extend beyond the present and the immediate future and require that we keep alive the realization that the Nation's task of winning the peace is fully as important as that of winning the War.

W. LEONARD CRUM
R. L. FUNKHOUSER
F. LESLIE HAYFORD
LOWELL J. REED
WINFIELD W. RIEFLER
FREDERICK F. STEPHAN
O. C. STINE
WILLARD L. THORP

Report of the Secretary

Preliminary membership statistics for the calendar year 1941 are included in the *Report of the Board of Directors*. On the basis of more recent information, however, it is possible to summarize the final statistics about the membership of the Association. During 1941 the total membership increased from 2,734 to 3,181, reflecting a net growth of 447 members. During the year 705 new members were elected and 20 former members were reinstated. Twenty members were lost by death during the year, including two Honorary Members, one Fellow, and one Life Member; 103 members resigned; the memberships of 155 were removed from the active rolls for failure to pay dues.

Membership statement, December 31, 1941

Honorary members	14
Corporate members	4
Fellows	102
Regular members	3,061
Total membership	3,181

One Fellow was a Contributing Member during 1941. There were no new Life Members during the year but the death of one Life Member was reported reducing the total number of Life Members to 36.

The death of the following members was recorded during the year: The Rt. Hon. Lord Stamp of Shortlands, and Gustavus Thirring, *Honorary Members;* James W. Glover, *Fellow;* Carl L. Alsberg, M. Ada Beney, Robert G. Brown, Arthur R. Bruder, R. L. Crandall, Robert F. Foerster, Bernadine A. Giliberty, Hubert W. Horn, Olin Ingraham, John Wells Morss, S. B. Pearmain, Paul A. Ryan, C. E. Sniffen, Hazel I. Spicer, M. W. Thompson, Jessamine S. Whitney, and Evelyn L. Yeomans, *Regular Members.*

R. L. FUNKHOUSER, *Secretary*

Report of the Treasurer

During the calendar year 1941 the Association's income from regular sources exceeded that in 1940 by about $1,600. In addition, the gross proceeds from the sale of the *Index to the Journal* amounted to nearly $600, bringing the total of the increase over 1940 to almost $2,200. An expansion of nearly $900 was recorded in membership dues; income from subscriptions increased about $300, and advertising revenue was approximately $400 greater than in 1940. In order to supplement the income from regular sources, the Board of Directors authorized an appropriation of $2,500 from the Centenary Sustaining Fund, compared with $1,500 during the preceding year. This expanded transfer to the general account of the Association largely offset the termination of the Rockefeller Foundation grant for general purposes.

The regular program of the Association's activities during 1941 resulted in an increase in expense of a little more than $600 over the corresponding total in 1940. Both office expenses and the cost of the *Bulletin* were larger than the year before, but salaries and wages and the cost of the JOURNAL were reduced. The total expense for the year was nearly $1,400 lower than in 1940.

The net excess of income over expenses, amounting to nearly $400, was accounted for largely by the net proceeds from the sale of the *Index to the Journal*. By action of the Board of Directors, the net proceeds from the sale were transferred to the Centenary Sustaining Fund.

The balance sheet and other detailed financial statements, with comparative figures for 1940, are included in the Report of the Auditors.

R. L. FUNKHOUSER, *Treasurer*

Report of the Auditors

To the Board of Directors of
American Statistical Association

We have examined the balance sheet of the American Statistical Association as at December 31, 1941 and the statements of income and surplus for the year then ended, have reviewed the accounting procedures of the Association and have examined or tested accounting records and other supporting evidence, by methods and to the extent we deemed appropriate.

The recorded cash receipts for the year were traced to the deposits shown on the bank statements and the amounts for dues and subscriptions were tested with the membership and subscription records. The paid checks and relative vouchers were inspected in support of the cash disbursements for the year. The cash balances and the securities owned as at December 31, 1941 were confirmed by inspection or by certificates obtained direct from the depositaries. We did not check the membership and subscription records in detail or make any independent verification of the inventory of old journals, the office records of which are based in part on data assembled in prior years, no recent physical inventory having been taken.

In accordance with a resolution of the Board of Directors, March 31, 1936, the life membership reserve is computed on the basis of the combined annuity table of mortality with assumed interest at 4% per annum and an assumed annuity of $5.00 per life member. The amount treated as income in each year represents the excess of the reserve at the beginning of the year plus interest for the year and new life memberships receipts over the required reserve at the end of the year.

In our opinion, the accompanying balance sheet and related statements of income and surplus present fairly the position of the American Statistical Association at December 31, 1941 and the results of its operations for the year, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

PRICE, WATERHOUSE & Co.

March 9, 1942

AMERICAN STATISTICAL ASSOCIATION

BALANCE SHEETS

Assets		December 31, 1941	December 31, 1940
Cash in bank and on hand		$ 1,753.69	$ 2,399.36
Accounts receivable		325.61	156.83
Investments:			
United States Savings Bonds, at redemption value		5,186.00	5,052.00
Stocks, at cost (at market quotations $3,875 and $4,158, respectively)		5,793.50	5,793.50
Inventory of old Journals, at approximate cost applied to salable quantities		1,779.91	1,791.75
Furniture and equipment, at cost less depreciation		541.81	627.07
Deferred charges		150.31	
		$15,530.83	$15,820.51
Liabilities			
Accounts payable		$ 1,183.18	$ 245.91
Special account—Allied Social Science Associations		481.81	398.33
The Rockefeller Foundation grant for the Index to the Journal:			
Total amount	$5,000.00		
Less—Portion expended in 1939 and 1940	3,627.69		
	$1,372.31		1,372.31
Less—Portion expended in 1941	912.74		
Amount returned to the Rockefeller Foundation	$ 459.57		
Centenary Sustaining Fund, per statement		3,618.45	4,450.47
Life membership reserve		2,315.79	2,411.91
Unearned income:			
Dues		1,267.12	610.42
Subscriptions		1,690.76	1,363.92
Surplus, per statement		4,973.72	4,967.24
		$15,530.83	$15,820.51

AMERICAN STATISTICAL ASSOCIATION

INCOME STATEMENTS

	Year ending December 31, 1941	1940
INCOME:		
Dues—current year	$14,002.00	$13,151.71
Dues—prior years	31.25	37.50
Life memberships	192.60	286.03
Subscriptions	3,723.25	3,394.50
Advertising	832.62	458.64
Reprints	174.40	180.10
Journal sales	293.07	284.33
Index to the Journal sales	566.00	
Special publications	71.07	18.94
Miscellaneous	128.25	61.18
Dividends and interest (after deducting $96.07 in 1940 and $96.48 in 1941 apportioned to life membership reserve)	208.34	191.98
	$20,222.85	$18,064.91
Appropriation from Centenary Sustaining Fund	2,500.00	1,500.00
The Rockefeller Foundation grants:		
For general purposes		1,500.00
For Index to the Journal (appropriation to cover expenses for year, per contra)	912.74	2,590.98
	$23,635.59	$23,655.89
EXPENSES:		
Journal—printing, mailing and reprints	$ 4,722.89	$ 5,048.25
Bulletin	1,441.75	492.84
Salaries and wages	11,682.29	12,269.20
Unemployment compensation tax	238.96	281.30
Rent	955.00	900.00
Office supplies, printing and mimeographing	932.76	725.92
General postage and carriage	710.04	535.20
Telephone and telegraph	155.62	212.45
Travel expense—officers	387.20	370.67
Mimeographing—committees	59.46	19.02
Storage of old Journals	72.00	72.00
Cost of old Journals sold	50.64	40.70
Miscellaneous expense	475.35	269.54
Depreciation of furniture and equipment	95.61	110.66
Membership campaign	170.80	
Membership directory		701.15
Expense—Index to the Journal:		
Expended from Rockefeller Foundation grant, per contra	912.74	2,590.98
Expended from Association funds	211.35	
	$23,274.46	$24,639.88
Balance carried to surplus	$ 361.13	$ *983.99*

AMERICAN STATISTICAL ASSOCIATION

SURPLUS STATEMENT

	Year ending December 31, 1941	1940
Balance at beginning of year	$4,967.24	$5,951.23
Add—Excess of income over expenses for the year, per income statement	361.13	
	$5,328.37	$5,951.23
Deduct—Excess of expenses over income for the year, per income statement		$ 983.99
Transfer to the Centenary Sustaining Fund of net proceeds from sale of the Index to the Journal	$ 354.65	
	$ 354.65	$ 983.99
Balance at end of year	$4,973.72	$4,967.24

STATEMENT OF CENTENARY SUSTAINING FUND

	Total	Year ending December 31, 1941	Prior to 1941
Contributions and pledges (relating to the support of the activities of the Association for a period of five years from January 1, 1940 to December 31, 1944)	$10,696.02		
Less—Pledges not collected at December 31, 1941, including $2,709.40 not due at that date	2,791.25		
Amounts received from contributors	$ 7,904.77	$1,202.00	$6,702.77
Interest received on bank savings account and increase in redemption value of securities	135.56	111.33	24.23
Transfer to Centenary Sustaining Fund of net proceeds from the sale of the Index to the Journal	354.65	354.65	
Total cash receipts	$ 8,394.98	$1,667.98	$6,727.00
Less—Expenses of campaign (printing, postage and temporary assistance)	776.53		776.53
Net receipts from campaign	$ 7,618.45	$1,667.98	$5,950.47
Appropriations by the Board of Directors to the general account of the Association in accordance with the budget:			
Year 1940 $1,500.00			
Year 1941 2,500.00	4,000.00		
Balance December 31, 1941, per balance sheet	$ 3,618.45		

List of Committees and Representatives for 1941

Committee on Fellows[1]

F. Leslie Hayford
Frank A. Ross
W. Leonard Crum
John Rice Miner
Theodore H. Brown

Committee on Nominations

Theodore O. Yntema, *Chairman*
Halbert L. Dunn
Dorothy S. Thomas

Committee on Investments[2]

F. Leslie Hayford, *Chairman*
George O. May
Walter W. Stewart

Biometrics Section Committee

C. I. Bliss, *Chairman*
Joseph Berkson, *Secretary*
A. E. Brandt
Alfred J. Lotka
Hugo Muench, Jr.
J. Neyman
Carroll E. Palmer
George W. Snedecor
Douglas E. Scates

Census Advisory Committee

William F. Ogburn, *Chairman*
Murray R. Benedict
Paul T. Cherington
J. Frederic Dewhurst
Luther Gulick
Frederick F. Stephan
Willard L. Thorp

Committee on Census Enumeration Areas

Howard Whipple Green, *Chairman*
Clarence E. Batschelet
Ernest M. Fisher
Charles S. Newcomb
Vergil D. Reed
Leon E. Truesdell
Shirley K. Hart
Lent D. Upson

Joint Committee on Metropolitan Districts (With the American Marketing Association and the Chamber of Commerce of the United States)

Paul T. Cherington[3]
T. W. Howard[4]
Glenn E. McLaughlin

[1] With terms expiring at the end of 1941, 1942, 1943, 1944, and 1945, respectively.

[2] Appointed in accordance with By-Law 5 to supervise the investment of the Association's surplus funds.

[3] Appointed by the American Marketing Association.

[4] Appointed by the Chamber of Commerce of the United States.

Joint Committee on Occupational Classification (With the Division of Statistical Standards, Bureau of the Budget)

Howard B. Myers, *Chairman*
Gladys L. Palmer, *Secretary*
E. Dana Durand
Meredith B. Givens
Edward D. Hollander
Merrill G. Murray
Leon E. Truesdell
Emmett H. Welch

Joint Committee on Relief Statistics (With the American Public Welfare Association)

Ralph G. Hurlin, *Chairman*
Paul Webbink, *Secretary*
Neva R. Deardorff
Emil Frankel
Anne E. Geddes
Helen R. Jeter
Howard B. Myers
Emerson Ross
Saya S. Schwartz
Herman M. Somers
Emmett H. Welch

Committee on Statistics of Hospitals

Graham L. Davis, *Chairman*
Joseph Berkson
Selwyn D. Collins
Edwin Crosby
Neil A. Dayton
Halbert L. Dunn
Gerhard Hartman
M. R. Kneifl
R. G. Leland
George St. J. Perrott
C. Rufus Rorem
Charles G. Roswell
A. Hardisty Sellers

Committee on Chapters

Robert R. Nathan, *Chairman*
Henry B. Arthur
Edwin B. George
Lester S. Kellogg
William A. Sturm
Charles W. Vickery, Jr.
Robert R. Williams

Committee on Sampling

Frederick F. Stephan, *Chairman*
George W. Snedecor
Alfred N. Watson
Samuel S. Wilks
Theodore O. Yntema

Advisory Committee to the National Roster of Scientific and Specialized Personnel

Halbert L. Dunn
Walter Mitchell, Jr.
Frederick F. Stephan
Ralph W. Tyler
Samuel S. Wilks

Representative on the Board of Directors of the National Bureau of Economic Research

Winfield W. Riefler

Members of the Social Science Research Council[5]

O. C. Stine
Edwin B. Wilson
Stuart A. Rice

Representative on the Council of the American Association for the Advancement of Science

Walter A. Shewhart

Representatives on the Joint Committee for the Development of Statistical Applications in Engineering and Manufacturing

Walter A. Shewhart
Churchill Eisenhart

Representative on the Sectional Committee on Standards for Graphic Presentation

A. H. Richardson

Member of the American Documentation Institute

Frederick F. Stephan

Representative on the Advisory Board of the American Year Book

Frank W. Notestein

Representative on the Advisory Committee to the Census Library Project

Richard O. Lang

[5] With terms expiring at the end of 1941, 1942, and 1943, respectively.

BOOK REVIEWS

GLENN E. MCLAUGHLIN
Review Editor

Introduction to Medical Biometry and Statistics, by Raymond Pearl. Philadelphia: W. B. Saunders Company. 1940. xv, 537 pp. $7.00.

A few months after publication of this book and after I had accepted an invitation to review it, the author, Raymond Pearl, died. I regarded Pearl as my most influential teacher as well as a good friend. It is natural, therefore, that the task of reviewing his last edition of a book which was the foundation of my own statistical meanderings should invite a somewhat different treatment from what ordinarily is due another edition of a well known text.

Pearl never did anything in a way that anyone else would do it, and the trait is exemplified in his *Medical Biometry and Statistics*. It is a good solid elementary text—the best in its field twenty years after its first issue—but it is more; it is Pearl's personality. In it the scholar, the prolific reader, the wit, the English stylist, are on exhibit, as well as the pontiff and the paradoxer. In his career Pearl published an immense amount of work and minuteness of statistical detail was characteristic of it, but always it was enlightened by a well defined general scientific *Anschauung*. His great scientific hero, and I suspect his conscious model, was Galton and he exhibited the same versatile naturalist's interest in an enormous variety of subjects, and the same desire to comprehend them quantitatively through the instrumentality of statistics. But, as revealed in the incisive introductory chapter of this book, his fundamental view was that the statistical method is only ancillary to the experimental. Characteristically one can find in his work a parallel series of investigations, on the one hand strictly statistical, on the other experimental. Illustrating this is his work on the application of the logistic curve to population growth, in which there were extensive investigations, with Lowell J. Reed, on human populations and at the same time intensive experiments on Drosophila. Similarly his idea that longevity is related inversely to the rate of expenditure of energy, first propounded with the support of occupational mortality statistics, was followed by elaborate experiments with the fruit fly and Cucumis melo.

The second chapter of the book deals with land marks in the history of biostatistics. While the author himself disparages the dry method of tabular historical outline which is the basis of the chapter, the selections for emphasis, the quotations, the comments, as well as the illustrations, furnish an entertaining as well as informative *aperçu* of the high points in the development of biomedical statistics. Chapters III–VI deal with the raw data of biometrics, their selection, and tabular and graphic presentation.

Beginning with Chapter VII the analytical technic of statistical methods is dealt with. Here students of statistics who have entered the field in recent years, and especially those who have been influenced by the ideas of R. A.

Fisher, will find an unfamiliar approach, and even what they may consider to be erroneous. Pearl was well aware of relatively recent "revolutionary" changes in statistics, and the failure to modify his text extensively in accord with them, wise or not, was deliberate. There is in the book no "theory of small samples," no "analysis of variance," no great emphasis on the "testing of hypotheses," nor any great show of the new statistical vocabulary currently in the making. These omissions are, in my opinion, in the main sound.

The eighth chapter, on life tables, is the best brief presentation of the subject of which I am aware, and in some respects the best regardless of length. The title of the book would seem to limit us to medical biometry, but this chapter exhibits the Pearlian touch, and the life tables of flies, roaches and automobiles are also dealt with. Here, as elsewhere in the book, crops out that, to Pearl, man was just another organism, though withal an extraordinary one, which a biologist could examine with interest.

In the ninth chapter, on adjusted death rates, Pearl comes near to losing his sense of humor over the existing confusion in terminology. (Or is it that this reviewer lost his?) He says in effect that since the statistical world has not had the sense to adopt his terminology, he will follow the rather inept official recommendations. Then he proceeds *not* to follow them!

The tenth chapter deals with the sampling error concept and presents some new tables for determining whether an observed difference between means is significant. The eleventh chapter on the theory of probability deals with the binomial expansion, its approach to the normal curve, and the estimation of the variability of a rate, while the following chapter presents the chi-square test and the four-fold table. In Chapters XIII and XIV on measurement of variation are taken up the calculation of moments and the derived statistics, the mean, median, mode, standard deviation, skewness and kurtosis, as well as some other matters such as class limits, the retention of decimal places in published constants, the comparison of groups with regard to composite items and graphic presentation of variability on the basis of range. These chapters are not happily headed so far as indicating their contents is concerned, and the soundness of some of the new suggestions contained in them is debatable. Chapters XV, XVI, and XVII deal with correlation and simple curve fitting.

The last chapter, XVIII, deals exclusively with the logistic curve, and here the guiding hand of Professor Lowell J. Reed can be discerned. It contains a clearly presented example of the fit of the curve by least squares using successive approximations to a Taylor expansion, and a bibliography on the logistic curve which we may consider definitive. Thus the last book of Pearl ends with a subject for which Pearl is perhaps most widely known, the logistic curve and population growth.

The development of Pearl's interests from the simple flora and fauna that furnish the *matériel* of the professor of biology to the "higher" forms and finally to man was continuous. By the time of his association with the Johns Hopkins University, where I knew him, his central interest had crystallized in *homo sapiens*. To study man in all his complexities sympathetically, and

yet to regard him always as an animal for cold scrutiny was his objective. He held consciously to the broad purpose of applying general biologic principles to the study of man and coined the special phrase "human biology" to convey this. His *Studies in Human Biology* and his later founding of the journal *Human Biology* were expressions of this idea. At the time of his death he was preparing for publication a volume on *Man the Animal.*

Pearl was of the type of the creative scientific worker rather than of the class room teacher. As a class lecturer he left a good deal to be desired, but in a broad sense he was a great teacher, for he affected mature students profoundly. Not a few, coming to his courses incidentally, were seduced by biometry as he represented it to make statistics their life work. It can fairly be said that his influence was greater than that of any single other person in the establishment of the biometric method in this country.

To many, Pearl was associated with a certain basic attitude in biological questions. He believed in the predominant importance of "nature" over "nurture," he emphasized constitutional as opposed to environmental factors in the breakdown of the organism and he laid great stress on genetic factors. He had a "hard boiled" attitude toward ameliorative efforts for improving the environment, when he felt that the basic weakness was in the host organism. He was emphatic in demanding evidence that well intended efforts necessarily produce desirable results, but he made these demands on himself as well as on others. He never uttered an opinion for serious consideration without a heavy support of evidential data amply and clearly tabulated. In the last several years there was notable in his writings what might appear to be a softening in his attitude. For instance he appeared to acknowledge that deliberate efforts at birth control could have a statistically significant effect on population, and that individual medical efforts could have a greater effect on general sanitary conditions than he had been wont earlier to assign to them. I have wondered what was the reason for this apparent change and I believe that it stemmed from the accumulation of data which convinced him. These questions were under continuous investigation in his own laboratory. He had a tremendous respect for the facts, and I believe he was simply convinced by the evidence.

Those who got close to Pearl as graduate students or laboratory colleagues found an amazing personality. He was interested in anything in the realm of the intellect and seemed to have read everything. He had an enthusiasm for Aristotle as though the latter were a contemporary biologist. He possessed a vanity of such colossal proportions as to render it almost impersonal and altogether charming. His weekly journal club meeting was an intellectual frolic where anything from Patten's *Embryology of the Chick* to Hemingway's *Death in the Afternoon* was reviewed with thoroughness and gusto. He taught the search for the objective truth and on all who worked with him he left an indelible mark. He will be remembered by them gratefully and affectionately.

Joseph Berkson

Mayo Clinic

Statistics for Sociologists, by Margaret Jarman Hagood. New York: Reynal and Hitchcock, Inc. 1941. viii, 934 pp. $4.00.

Students of sociology will find in this book an introduction to the statistical tools of their trade rather than an exposition of statistical theories *in vacuo* or in any other medium. But a nine-hundred-page textbook "designed primarily for the first year of statistics for students in sociology" who are presumed to have mastered "no prerequisite of mathematics beyond freshman college mathematics" inevitably raises some troublesome pedagogical dilemmas. Eschewing all higher mathematics while undertaking to explain "all the basic statistical methods which have been used in sociological research and some of the newer ones which have not yet found wide application in sociological fields" has led in this instance to some precarious tightrope walking between rule-of-thumb precepts and such Platonic dialogue as the following:

A. . . . What do other sociologists do about tests of significance in such situations?
B. They do everything imaginable . . .

On the other hand, the text contains many lengthy computations whose rationale is surely beyond the comprehension of most students of freshman college mathematics. Again, although the student is repeatedly and wisely admonished always to consider the basic assumptions of each method that he is tempted to use, his attention is likely to be distracted by occasional digressions from discussion of first principles into minutely detailed instructions for the use of calculating machines to compute various functions on a mass-production basis.

Aside from such shortcomings—probably unavoidable in a text which aims to do so much for novices—the book is not only sound and up-to-date but extremely comprehensive. It should appeal to students who are above the average in intellectual maturity and scientific curiosity. Parts of it, especially those dealing with the newer concepts relating to sampling and analysis of variance and co-variance, should be required reading for many social researchers whose statistical training was derived from the standard textbooks of no more than a decade ago and who do not yet realize that Fisher and others have outlawed inverse probability.

The book is divided into five parts—quantitative methods in sociology, descriptive statistics, inductive statistics, statistics of relationship, and selected techniques for population data. The last part includes treatment of birth and death rates and the construction of life tables. Nine appendix tables embrace integrals and ordinates of the normal curve, *t*, *chi-square*, *F*, *Z*, and the life-table functions *q* and *m*. A systematic collection of the formulae scattered through the text would have enhanced the book's usefulness for reference.

ELBRIDGE SIBLEY

Bowdoin College

The Theory of Econometrics, by Harold T. Davis. Bloomington, Indiana: The Principia Press, Inc. 1941. xiv, 482 pp. $4.00.

The contents of this book are encyclopedic. One finds in it a description of depreciation formulae and of various methods of computing life insurance premiums; the author discusses the concept of utility and presents a detailed theory of international exchange; he devotes considerable space to the problems of taxation and makes passing observations concerning the interrelation between interest rates and the outcome of presidential elections.

In his endeavor to present a complete, up to date picture of the application of quantitative methods of analysis in economics Professor Davis refers to the works of more than three hundred different authors. Numerous bibliographical footnotes are implemented by summaries of selected literature attached to each of the eighteen chapters.

Of the two principal approaches through which quantitative analysis enters the field of economics—pure theory and statistics—both are given equal attention. No attempt, however, is made by Professor Davis to integrate either one in a unified system.

Although essentially a compendium, the book contains here and there original contributions. As many an econometrician with a background of mathematics and physics, the author shows great weakness for analogies between familiar definitions of theoretical physics and some basic concepts of pure economics ("isomorphism between money utility on the one hand and entropy on the other" p. 171 etc.). If his more cautious colleagues should object to Professor Davis' readiness to develop an elegant deductive argument on the basis of a few bald factual and theoretical assumptions, he will be able to point out that some of the best known authorities in the field of business cycles theory reach far bolder conclusions on the basis of much more dubious assumptions—and they get away with it.

The appearance of this volume raises again the question whether "Econometrics" as defined by Professor Davis should and could be usefully treated as a distinct, separate part of economics. It is true that some investigators show a greater facility in and interest for the mathematical formulation of their problems and numerical manipulation of their data than others. The powerful tools of quantitative method have definitely proven their worth in application to economic analysis and thus they are bound to become common property of an ever wider circle of economists. It can be hoped that a working knowledge of the fundamentals of mathematical analysis will soon be as much required from an advanced student of economics as the knowledge of foreign languages. But precisely for this reason a "Theory of Econometrics" can not be more usefully established as a separate field of advanced studies than for example a "Theory of Economics treated with the help of foreign languages." The use of economic problems in teaching mathematics to economists is of course highly advisable, but so is the use of Barone and Böhm Bawerk in teaching them Italian or German. However, before Econometrics have found their natural place in the general body of Econom-

ics a great pedagogical task has to be performed. Professor Davis' book will be of invaluable help to those engaged in teaching mathematics to economists and economics to mathematicians.

WASSILY W. LEONTIEF

Harvard University

The Elements of Statistics, by Elmer B. Mode. New York: Prentice-Hall, Inc. 1941. xvi, 378 pp. $3.50.

Many teachers of statistics must be conscious of the desirability of introducing into their beginning courses more extensive mathematical treatments of the subject than often have been employed in the past. One deterrent has been the lack of suitable textbooks that are at once adequate and still simple enough mathematically to be used with classes in which the students have a mixed (and usually minimum) mathematical training. To many instructors Professor Mode's book may offer a solution. It presupposes no mathematics beyond secondary school geometry and algebra, and yet it is comprehensive and contains much material of value in the study of the elementary mathematics of statistics. Although the author employs an elaborate symbolism it is always carefully defined, and the subject-matter is explained in great detail so that small points which often trouble the beginner are not overlooked. The book is constructed upon the premise that the science of statistics may be studied from a broad general standpoint, and that once the principles are learned, applications may be made to any particular field of interest.

Fundamentals are not neglected in this textbook. The chapter on computation, dealing with limits of accuracy, the elimination of unnecessary calculations, and the use of the slide rule, should prove helpful to beginning students to whom these are often small but vexing problems. There are many worked examples to accompany the discussions of methods, and there are an abundance and a great variety of exercises for solution. Somewhat more attention might have been given to the technique of chart construction in the chapter on that subject; but the charts and graphs of the book itself must be cited as excellent examples of statistical draftsmanship.

The chapters on averages and those on dispersion and moments are very well done, and provide material on the mathematical properties of these measures not usually included in an elementary text. Other chapters of outstanding merit are those on frequency distributions, the frequency curve, and curve fitting. On the other hand, the treatment of index numbers seems rather narrow and limited since it is confined almost entirely to the matter of formulas.

A feature of the book is the introduction at an early stage of the concept of probability and the development of it throughout the text. The student is led gradually and carefully to the final chapters in which the topic is brought to culmination in the discussion of binomial distribution, and in which he is given an introduction to sampling theory. Discussion of measures of reliability is confined principally to large samples. The treatment in rela-

tion to small samples is of necessity somewhat limited, in keeping with the scope of the text. The Chi-square function, however, is given more than passing attention, and a number of examples of the practical application of the Chi-square test help to explain the concept.

In general, the book is very well written, and is marked by a clear, lucid exposition of the mathematical principles involved. It is a book that may require close application from the student, but also one that will repay him for the effort.

Frederick R. Ottman

New York University

Business Statistics, by Martin A. Brumbaugh and Lester S. Kellogg. Chicago: Richard D. Irwin, Inc. 1941. xv, 913 pages. $4.00.

This book is a substantial addition to the growing list of excellent texts prepared primarily for college courses in business and economic statistics. It is designed for the statistical consumer rather than the statistical producer; for the ordinary user rather than the specialist.

The emphasis is on the simpler techniques of collecting, presenting, and analyzing business data and upon affording sound bases for the interpretation of statistical materials. The authors do not introduce mathematics beyond arithmetic and intermediate algebra, including series and the use of logarithms. The majority of business men and economists who have occasion to make use of statistics are not helped by the mysterious symbolism and the involved refinements of the mathematical statistician. The layman in statistics sometimes suspects that the advanced specialists are so enamored of their own abstruse mathematics that they fail to appreciate the importance of, and need for, a more democratic acquaintance with sound statistical techniques.

The authors have devoted considerable space to those aspects of statistical method that are especially pertinent to business and economics. The principles of sampling, the collection and tabulation of data, the use of graphs, and the treatment of time series make up the bulk of the text. Less attention is given to averages and frequency distribution than to trends, index numbers and cycles. The book includes a rich variety of illustrative matter not strictly "business statistics," for among the materials used for explanation or example are those referring to prices, wages, foreign trade, cost of living, the public domain, public health, straw ballots, accidents, marriages, air forces, and postal receipts. The reviewer notes with satisfaction the attention given to the limits of the reliability of the various statistical measures; it would not have been out of place to have included also a caution against some of the "horrible examples" of misleading graphic and pictorial representation which unfortunately abound in popular business and general literature. A helpful innovation in a text on statistics is the inclusion of two chapters on the collection and use of materials from library sources.

Kenneth Duncan

Pomona College

A Significance Test for Time Series, by W. Allen Wallis and Geoffrey H. Moore. New York: National Bureau of Economic Research, Inc. 1941. xii, 59 pp. 50 cents.

The authors have examined some of the characteristics of order that are dependent only on the relative magnitudes of the terms in time series and have derived a pseudo χ^2 test for cyclical fluctuations. Their stated objective is to choose "both a form of the population and the characteristic(s) by which randomness is to be judged . . . entirely without reference to the sample."

Starting with an assumed sequence of N terms, no two of which are identical in magnitude, they derive the exact distribution of lengths of rises and declines (phases or runs), excluding the end or "incomplete" runs, for a theoretical arrangement in which the frequency for each length is the average for the $N!$ possible independent arrangements. Although a correction factor is indicated for the case where the end runs are included, the simple expression

$$\frac{2}{(d+2)!}[1+(d+1)(N-d)]$$

for the number of runs of length d or over in such a theoretical distribution is not given. An empirical check of the distribution of "complete" runs is shown for three groups of series ($N=25$, 50, and 75). For this purpose the theoretical frequencies are adjusted only with respect to N, the length of the series and the total frequencies are not identical to the corresponding observed totals. This could, of course, have been avoided by including the end runs and counting the runs (rises and declines) of length, $d=0$. When these are included, the number of runs in any arrangement is $(N+1)$.

The distribution of χ_p^2 is obtained by using a three term comparison ($d=1$, 2, or 3 or over) between the observed and the theoretical distributions of "complete" runs for each sample used in the empirical check. Exact distributions (except for a minor discrepancy in that $(2N-7)/3$ is taken as the total theoretical frequency in each case) are shown for $N=6$ to 12 inclusive and these are compared with the empirical distributions to reach an approximate distribution of χ_p^2 for use when $N>12$.

One of the simplest arrangements which is usually recognized as "nonrandom" is one in which each successive term is higher than the preceding. Although such an arrangement would be expected to occur only once in $N!$ arrangements, N would have to be 19 or over to reduce the probability associated with the empirical χ_p^2 to .01. The probability values for $N=6$ and 12 are .4528 and .0924 respectively.

The distributions of turning points and numbers of completed runs are also obtained. It is shown that these distributions approach normality for $N \geqq 12$.

Tests based on these distributions are illustrated by application to annual production, yield per acre, and acreage harvested for sweet potatoes in the

United States from 1868 to 1937. As applied, the test selects only one of these as showing evidence of cyclical behavior even though each one presents evidence of definite primary trends which can be detected by other types of analysis. A basis for choosing one of a group of fitting curves with various values of χ^2_ν is presented.

P. S. Olmstead

Bell Telephone Laboratories

Training and Recruiting of Personnel in the Rural Social Studies, by Theodore W. Schultz assisted by Lawrence W. Witt. Washington: American Council on Education. 1941. xiii, 340 pp. $3.00.

This useful and timely report on the pressing problem of personnel selection in rural social studies was prepared under the direct supervision of the following distinguished committee: Edwin G. Nourse (Brookings Institution), Theodore W. Schultz (Iowa State College of Agriculture), Waldo E. Grimes (Kansas State College of Agriculture), William I. Myers (New York State College of Agriculture), T. Lynn Smith (Louisiana State University), and O. C. Stine (Bureau of Agricultural Economics, U.S.D.A.).

The composition of the committee, representing both Federal and state, both educational and administrative points of view, fitly reflects the need for coordination in studying and in meeting the problems raised by the Report. Rural social studies have experienced a mushroom growth since the last war, and the time for reckoning and for planning is at hand.

While the central problem is that of ensuring a proper quantitative balance between supply and demand in personnel, the committee has found that adequate reform in this line involves reorganization of training programs and promotional practices at the undergraduate and graduate levels and in the official staffs of Land-Grant Institutions and Federal agencies.

At the very basis of the whole program lies the curriculum. Agricultural Economics as a field has never been so well systematized from the standpoint of instruction as some of the older social science disciplines. Undergraduates must gain basic intellectual training in sociological and economic theory, as well as in statistics, history, psychology and other related studies. At the graduate level this discipline must be continued, care being given to correlate field work with theory.

On the staffs of Land-Grant Colleges provision should be made to allow graduates adequate opportunity for leaves of absence. Extension work, experience in both state and Federal agencies, research, intimate knowledge of the problems of two or more different regions should all find their place. The able graduate student must be encouraged to undertake the training which will fit him for future service; he must not be treated as a convenient "assistant" on whom to unload departmental dirty work.

Both in the college departments and in the governmental bureaus efficient personnel practice is vitiated by too much inbreeding. While Civil Service

delays account in part for the hesitancy of government agencies to look "outside" for new recruits, there is also, as in the colleges, a tendency to mistake conformity of method, background and general outlook with prerequisites for efficiency.

The committee concludes its admirable survey with the statement that 50–75 individuals with 3–4 years of graduate training will be needed every year. Measures must be set in motion to regulate the admission of candidates, the elimination of the unfit, and the competency of the survivors.

E. Y. HARTSHORNE

Library of Congress

The Prediction of Personal Adjustment, by Paul Horst and Others. New York: Social Science Research Council, Bulletin No. 48, prepared for the Committee on Social Adjustment under the Direction of the Subcommittee on Prediction of Social Adjustment. 1941. xii, 455 pp. $2.00.

Paul Horst, editor of *Psychometrika*, engaged for some years in personnel selection research for a large industrial concern, and a consistent contributor of statistical articles in the field of mental measurement, was called to Chicago last year to assume charge of the short-time production of a monograph on methods of prediction in the general field of adult adjustment. With the assistance of several workers and the counsel of various committees, the monograph was put together in something over three months. The resulting volume reflects the competence of the contributors, the breadth arising from the mingling of various backgrounds, and the diversity of approach found in different disciplines. No effects of haste are apparent, other than possibly the unreconciled frames of reference of the several writers.

The volume presents both the rationale and technical details of prediction. It is concerned (primarily with respect to illustrative material) with the prediction of success in four areas: vocations, education, marriage, and parole. Part I, comprising two-fifths of the text, presents the logic of prediction. It is relatively simple, straightforward, non-mathematical exposition. It presents, in its eleven chapters, a comprehensive and critical statement of considerations and methods; some of the fundamental material is new, and certainly there is no other single treatment that approaches the compass and definition of this. Part II, comprising some sixty per cent of the text, is technical, and illustrates both the mathematical background, and the application to empirical data, of the methods described in the earlier part. Part II is highly original, ingenious, and resourceful. It marks an advance over methods ordinarily understood and employed.

The reader will find, in addition to the general discussion in Part I, a detailed critical treatment of the case study method as a means of prediction; new light on random sampling in measurement; new methods of solving multiple correlation and regression coefficients; procedures for scaling items, and also attributes; methods for reducing the number of variables; choosing

predictable criteria; simplified ways of handling ratings; the function of "suppression variables," and other topics. Richardson's section on combination of measures is the most realistic treatment of weighting which the reviewer has seen.

The entire volume may be regarded as lying, not solely in the field of prediction, but in the emerging statistical field of combinations of measures to index a complex trait through appropriate composites. The development of this area—accurate, sensitive, and faithful indexing or measurement of variables representing general concepts—is of as much basic importance to those interested in the maturing of statistical science in the social fields as is the somewhat narrower problem of estimating over an interval of time. Though somewhat aside from its avowed purpose, the entire study represents a wholesome and timely recognition of the complexity of traits in social or psychological fields, and the technical developments in the work may be regarded as a contribution to much needed refinement of indexing or measurement in areas that are still somewhat nebulous.

Done in connection with a personnel which varied in interests from case-study methods to almost pure mathematics, the work represents something of an attempt to bring together quantitative and non-quantitative approaches. In this it is only partly successful; the combination is more in the nature of an assemblage than an integration. The transfer, on the part of a writer, from thinking in pure mathematics to thinking in practical fields is not accomplished easily. One feels, without prejudice to the excellence of the mathematical contributions, that certain portions of Part II represent an over-confidence or over-enthusiasm for quantitative methods, even if mechanically performed; the volume is clearly concerned more with the development of theory than with the improvement of immediate practice.

Through its two distinct parts, the volume makes an appeal to both the general and the technical worker. It is made readable by excellent organization, clear exposition, and meticulous editing.

DOUGLAS E. SCATES

Duke University

Nation and Family, The Swedish Experiment in Family and Population Policy, by Alva Myrdal. New York: Harper and Brothers Publishers. 1941. xv, 441 pp. $4.00.

Sweden, 1934–39, was the scene of the most dynamic integration of social philosophy, statistical research, and political action yet recorded in human history. The principal components in this synthesis were social-democratic institutions and ideology, academic leadership of high order, population analysis, economic research, biological and psychological studies, and extensive social security, health, housing and welfare programs. The catalytic agent was a new principle, initiated in academic cycles, bruited in popular discussion, and formulated under governmental auspices. This new principle was a democratic population policy directed toward explicit quantitative

and qualitative objectives through the integration of the interests of people as members of families and as members of the nation. Through reference to this principle and the new focus of national interest in children and the family, the whole structure of Swedish economy was re-interpreted, re-oriented, and to a considerable extent actually re-vamped in legislative and administrative acts. The movement was aimed at long-range objectives, rather than quick and spectacular results. It has been temporarily side-tracked by the necessity of directing all the energies of the Swedish nation to preparations for defense. It can, therefore, be given a pragmatic test only if, and when, an international order is established that will again make possible free experimentation in democratic ways of life.

In *Nation and Family*, Alva Myrdal, who was one of the principal actors in this drama, presents to the English-reading world a broad exposition of its conditions, theory and development. This account of an intellectual revolution in Sweden is likely to have far reaching influence on social theory, the direction of statistical research and political progress in other countries. The general theory, which includes the most comprehensive population policy yet enunciated, is appropriate to any country characterized by advanced technology and democracy. The particular synthesis of various factors in economic and social life effected in Sweden is, of course, not wholly appropriate to any other situation. It will, nevertheless, be extremely interesting to observe the reactions of scientists, administrators, and theorists to the stimulus thus provided for a re-examination of objectives and programs in various fields, e.g. public housing (hitherto characterized by a peculiar dearth of coherent theory), nutrition, employment security, health security, birth control, eugenics, and child welfare. The specific treatment of such topics as economics of homemaking, housing for families, feeding a nation, health for the nation, social security and the social care of the handicapped, opportunities for education, recreation and the family will facilitate its use by specialists in various fields.

The author combines an exposition of theory, frankly related to value judgments which are so far as possible stated explicitly, with an objective analysis of conditions and events. The treatment is well balanced and candid; but it naturally reflects personal interests and preferences. The treatment of general economic theory in relation to population policy has been more fully developed by Gunnar Myrdal in various lectures in this country, including those published in *Population—A Problem for Democracy*. The quantitative materials in *Nation and Family* are presented in brief and popular form—sometimes with a regrettable absence of precise definition. The statistician will regret the lack of an extensive statistical supplement. This need is met, at least in theory, by extensive references to Swedish statistical sources. Moreover, an extensive and precise treatment of some of the materials covered is now available in Thomas's *Social and Economic Aspects of Swedish Population Movements, 1750–1933*. Mrs. Myrdal does present much well selected and significant quantitative material, but her principal contribution

to the statistician is a brilliant conceptual organization of critical problems in their social and political context.

The treatment throws light on many neglected problems in population theory, as, for example, that of the "social substratum." It provides the background for a wide variety of institutional changes. Above all, it is characterized by breadth and intellectual integration. It should prove an antidote to many ill-conceived and short-sighted social reforms. Finally, the book can be recommended to all social scientists for sheer intellectual stimulus.

Frank Lorimer

The American University

The Swedish Collective Bargaining System, by Paul H. Norgren. Cambridge: Harvard University Press. 1941. xv, 339 pp. $3.50.

This is a carefully done description and analysis of the collective bargaining system in Sweden. It sets an excellent example for a pioneer study in this field. There are no really good studies in English of the trade union systems of European countries other than Great Britain. The author has taken one of the most successful of the European systems for probing; he has proved it to be a manageable task for concrete presentation; he has hewed closely to his task and has come out with a scholarly study that is a distinct contribution to the subject of the validity and utility of collective bargaining in modern industrial society.

A somewhat telescoped outline of the volume indicates its coverage: development of the trade organization, of both worker and employer in Sweden; the collective agreements and their contents, more particularly the cost-of-living provisions and the piecework system; the technical making of the agreement and governmental intervention; the subordinate processes of local agreement-making under the general controlling agreement and interpretations of agreement by the Labor Court; and finally, the significance of the system as a whole for the Swedish economy and its probable applicability to the United States. The volume is written with an unsual and refreshing clarity and objectivity, and written only after research and field study in Sweden. It shows a balanced comprehension of social desiderata and economic possibilities.

Professor Slichter's Foreword is in the nature of a review of Dr. Norgren's study. He points out features of interest to both unions and employers in America: the high degree of organization on the part of Swedish employers; the controlling influence of the national trade union federation over its members; the prevalence of national agreements and the absence in those agreements of detailed restrictions limiting output; widespread existence of piecework, which extends into the building trades; safeguarding on both sides of the right to strike, even at the expense of considerable lost time from strikes, which interestingly enough appears to be about as great as in the United States.

Another aspect of the Swedish system is effective intervention of the Government in all industrial disputes and the ready acceptance of it by both employers and workers. Such intervention takes place not only on the level of the interest disputes, but also in justiciable disputes—the author uses the word"interpretational"—which are handled by a special Labor Court. The author might also have mentioned the evolutionary trial and error method by which Swedish disputes legislation has developed. This legislation frequently has been enacted for fixed periods of time, and has had definitely to be reconsidered at the end of such period. The high quality and experience of the mediators have accounted for much of the successful handling of disputes. Nor does the author, it seems to me, emphasize sufficiently the wisdom of the Government and its representatives in weighing "the more objective factors—the swings of the business cycle, the degree of organization on both sides, and so forth." It is this wisdom on the part of the Government that has, I think, made "the effect of mediation on the final outcome of the bargaining process" of more than "minor significance." The Government has not tried to outface economic realities by fiat; neither has it bolstered first one side and then the other; nor has it become an administrative agency of the special interests of either side.

LEIFUR MAGNUSSON

The Library of Congress

Industrial Wage Rates, Labor Costs, and Price Policies, by Douglass V. Brown, Charles A. Myers, John A. Brownell, John T. Dunlop and Edwin M. Martin. Temporary National Economic Committee. Monograph No. 5. Washington. 1940. xxvi, 172 pp.

This study should be examined carefully by anyone engaged in theoretical or empirical work on the economics of the firm. It demonstrates the wealth of economic data available in business records and suggests many ways in which these data may be turned to account.

The first half of the monograph analyzes the experience of two paper companies and two cotton textile companies over the period 1936–38, and of two shoe companies for the years 1931–38. A more intensive case study of the International Harvester Company over the period 1929–37 comprises the second half of the volume. Information is provided on the movement of wage rates, unit labor costs, unit total costs, and prices, on the accounting procedures by which cost figures were derived, and on some of the considerations which appeared to influence price and wage decisions.

The case studies are suggestive rather than productive of definite conclusions. The dominant influence of overhead on the cyclical movment of total unit costs stands out clearly, particularly in the Harvester Company case. The authors suggest that the role of costs in price formation is essentially different in the two major phases of the cycle. "This survey suggests that when sales are falling, business men commonly regard themselves as being forced to lower costs to conform to reduced prices and that, when business is

improving, they think of prices as being raised to conform to higher costs." This lack of symmetry undoubtedly exists, but one may doubt whether the role of costs has been correctly stated. Do business men raise prices in recovery because their own costs have risen? Or are they able to raise prices because the costs of *other producers* have risen sufficiently that all will concur in a price increase?

A number of the firms studied show a systematic deviation of average hourly earnings from wage rates over the course of the cycle, and an increasing secular deviation of unit labor costs from wage rates. The analysis of these deviations in the Harvester Company is particularly interesting. Changes in wage rates and labor costs seem in general to play a very minor role in price formation. Few of the cases studied show any clear connection between the timing and magnitude of wage and price changes.

Research into business decisions must increasingly probe beneath the superficial descriptions which business men give of their behavior and penetrate into the basic operating records of the firm. It is to be hoped that this illustration of what can be done with business records will stimulate additional investigation both by individuals working on one or a few firms and by organized groups able to analyze a considerable sample. One may also hope that this work will be directed increasingly toward answering the questions posed by economic theory in this field, and that we shall in time have a thorough going revision of the economics of the firm.

LLOYD G. REYNOLDS

The Johns Hopkins University

Hourly Earnings of Employees in Large and Small Enterprises, by Jacob Perlman. Temporary National Economic Committee. Monograph No. 14. Washington. 1940. xv, 94 pp.

Wage data collected in recent years by the Wage and Hour Division of the Bureau of Labor Statistics are here assembled and focussed on the question whether employees of large enterprises enjoy higher average hourly earnings than employees of small enterprises. No clear relation between hourly earnings and size of enterprise was discovered in eight relatively small-scale industries: shoes, leather, radio parts, furniture, hosiery, cotton goods, woolen and worsteds, and knitted underwear and outerwear. Hourly earnings were found to increase with size of enterprise in eight highly-concentrated industries: meat packing, iron and steel, electrical goods, radio sets, explosives, soap, fertilizers, and tobacco prod[illegible]s. This tendency existed, moreover, within each region of the country, e[illegible] size of community, and each grade of labor. A net relationship betwee[illegible]ze of company and hourly earnings of employees is strongly indicated, though this was not tested by multiple regression analysis.

The qualifications which must be attached to these results are carefully noted by the author. The fact that large and small enterprises nominally in the same industry may not be producing the same p[illegible]'uct raises difficul-

ties of comparability which can never be entirely surmounted. The distribution of hourly earnings does not give us the distribution of either wage rates or unit labor costs. Where piece rates are used, high earnings simply indicate high man-hour output. Higher earnings in large enterprises might be due very largely to the fact that they make greater use of piece-work and bonus systems which induce a greater input of effort by the worker.

Frequency distributions of hourly earnings for large, intermediate and small establishments in four industries are published in appendixes. The upper limit of the range is usually about the same for small companies as for large, but the lower limit is considerably lower for small concerns. The distributions are markedly symmetrical, but with a tendency toward bimodality in the distributions for intermediate and small producers.

These results suggest many interesting problems. To what extent are the observed differences in hourly earnings attributable to differences in man-hour output rather than in wage rates? Do the higher earnings obtained in large enterprises allow them to skim the cream from the labor market? Are differences in wage rates largely offset by differences in labor efficiency in large and small enterprises? Case studies of large and small enterprises selling in the same product market and buying labor in the same community might furnish very useful evidence on these matters.

LLOYD G. REYNOLDS

The Johns Hopkins University

Economics of Social Security, by Seymour E. Harris. New York: The McGraw-Hill Book Co., Inc. 1941. xxvi, 455 pp. $5.00.

Professor Harris' purpose in writing on this subject is made clearer by the subtitle, which indicates that the volume describes "The Relation of the American [Social Security] Program to Consumption, Savings, Output, and Finance." The book is an outcome of the author's interest in the problem of investing social security funds. He is impressed with the necessity of attaining perspective in evaluating the probable impact of these funds on the whole economy and particularly on the volume and fluctuations of output and employment. As a result, social security, as the author uses the term, means, for the most part, the system of old age and survivors' insurance, with a much lighter emphasis on unemployment compensation and no consideration of other phases of the program.

There are three major divisions, which include a total of twenty-one chapters. Part I considers the relationship of the program to probable output. Part II describes effects of the system on finance. Part III is concerned with the incidence of costs of the program.

In each major division, there is an extensive citation of varying viewpoints, well organized, logically arranged, clearly quoted or paraphrased. A wide range of pertinent statistical data is included, and footnote references provide a fairly comprehensive bibliography of recent literature on economic implications of social security measures. Major divisions and chapters are

effectively arranged, in that varying viewpoints are first contrasted, after which the author seeks to strike a balance in a concluding section or paragraph. As a result, the presentation sustains the reader's interest and stimulates a critical viewpoint, which, in the opinion of this reviewer, gives the volume its greatest value and justifies the opinion that it is a "must" on the reading list of all those who are charged with responsibility for administering these features of the social security program. Because of this arrangement, also, the book will be useful in the classroom, where opposing viewpoints may be criticized in more detail.

In other words, Professor Harris has provided a powerful incentive for thinking critically of the probable effects of our old age security program. He repeatedly notes, for instance, the possibility if not likelihood of the repudiation of obligations under old age provisions. Indeed, the volume is replete with suggestions, implications, and possibilities, and they represent its most important contribution. For the conclusions to which the author comes are, as would be anticipated in a study in which so much emphasis is placed on authority and so little on pertinent evidence, distinctly controversial. That is particularly true, also, because the author attempts to juggle and balance a coterie of economic tendencies, actuarial statistics, and principles of social justice. In effect, the reasoning process attempts to follow the threads of an endless number of variables through a complex maze of arguments and thereby to arrive at a series of tenable conclusions. By such a process, it is possible to formulate hypotheses, but anything in the nature of a positive conclusion requires more tangible evidence. Illustrations of this point are numerous. After one hundred fifty pages of citation and quotation, the conclusion as to the incidence of costs is far from decisive. The conclusion as to the impact of the program on prices is a series of questions. The author's decision that, on balance, "the stagnationists have a strong case" is of similar caliber, as is the declaration, in curious scientific language, that "our sympathies are with the spenders."

Aside from its value in focussing attention on the place and importance of social security in the total economy, therefore, it appears that the major value of the book is its profusion of illustrations of the need for empirical studies to supplement armchair hypotheses.

Dale Yoder

University of Minnesota

Federal Finances in the Coming Decade: Some Cumulative Possibilities, 1941–51, by Carl Shoup. New York: Columbia University Press. 1941. vii, 121 pp. $1.00.

Essential Facts for Fiscal Policy. New York: National Industrial Conference Board. 1941. 135 pp.

It has often been said that although the Treasury plans only from year to year, it is long range planning of finances that is required. Professor Carl Shoup has boldly and successfully attacked the problem of long range fiscal

planning. That his estimates, or better, his informed guesses may prove to be wrong, is of secondary importance. In fact Pearl Harbor has already dated many of his findings. What is of crucial importance is his method of approach, his assumptions, his selection of significant variables and the expert use of series which throw light on this problem. Economists, civil servants and statisticians will, I am sure, be grateful to Professor Shoup for this excellent monograph.

For the next 10 years he estimates expenditures, tax receipts inclusive of yields associated with five successive revisions in the tax structure, each in turn contributing additional amounts of taxation, and the rise of debt in the absence of tax revisions and on the assumption of these five successive changes in the tax structure. The author does not neglect the relation of taxes to income, of taxes to prices, of the rise of yield of one tax upon the yields of others, of the effect of high tax yields on sales of securities.

Professor Shoup is concerned almost exclusively with the fiscal aspects of the problem; but he is nevertheless anxious that fiscal policy be used as a means of keeping prices from rising. It is possible, of course, to deal with the price problem exclusively through controls. The cost then would be a complicated and comprehensive administration, regimentation, and a rapidly growing public debt. The price problem would be solved at the expense of the public debt. It would have been helpful if Professor Shoup had suggested the relative contributions to be expected of taxes, controls, and monetary policy. Washington needs guidance here.

In discussing the sale of government securities, Professor Shoup raises many interesting questions. What is the magnitude of probable sales to institutions and individuals? What limitations are placed on sales by banking capital and cash reserves? What is the elasticity of supplies of loanable funds in response to a rise in the rate of interest? In particular, will the cost to the government of the rise in the rate of interest exceed the new money attracted by the increase of the rate on government bonds? On these and many other issues Professor Shoup sheds new light.

He is perhaps overanxious concerning the limits on sales of bonds to banks set by cash reserves and capital. The monetary authority can deal adequately with these problems; and the danger of rising rates of interest on the value of assets and hence on the adequacy of the capital structure can be averted through Treasury guarantees against depreciation of securities. Advances in this field are beginning to be made. Professor Shoup might also be encouraged by British experience in the last two years: Vast drains on the capital market have been accompanied by a decline in the rate of interest on public securities. In almost two years of warfare the price of all fixed interest yielding securities rose by almost 15 per cent. The demand for government bonds, observe, stems not only from existing supplies of money, but also from new supplies; not only from normal savings, but also from additional (or diverted) savings induced by higher incomes and limitations on spending both for consumption and capital purposes. Through a control of

the supply of money and the demand for cash for spending, the government can assure the Treasury a reasonable rate of interest. And banks should not be guaranteed a rate in excess of the variable costs involved in absorbing additional public debt; and when outlets for cash increasingly are closed private purchasers will be pleased with the opportunity to purchase government securities at 2 per cent.

Professor Shoup's alternatives for increasing public revenues are on the whole eminently sensible. He suggests under his first two alternatives large rises in the income taxes and other taxes on capitalist income; under the third, excise duties; under the fourth, manufacturers' sales taxes; and under the fifth, payroll taxes. The respective additions to receipts for the fiscal year 1944, in which year the total gains would be a maximum, are under these successive alternatives $3.7, $1.3, $1.0, $1.3 and $0.8 billion. Total revenue would then rise to $21 billion in the fiscal year 1944. At an income of $100 billion the total tax load for all governments would then be roughly 30 per cent of national income. In the absence of large curtailments imposed on industry by priorities, rubber shortages, etc., I would have suggested that Professor Shoup underestimates the tax potential in the excise field. The reviewer would also suggest a greater increase in payroll taxes than that proposed by Professor Shoup. Despite the increased burden of income taxes, a rise of payroll taxes from the present low level by at least 4 per cent seems eminently desirable. The rise of yield would then be of the order of $2 billion annually. (I assume broader coverage than is now had under the Social Security Act.)

The National Industrial Conference Board Study deals with somewhat similar problems. They apparently would rely heavily on a rise of income tax induced through a lowering of exemptions. Estimates of yield are based on the assumption that the yield of surtax will be given by the existing ratio or normal tax yield to total income tax yield. This assumption has, of course, been violated by the 1941 Revision which relied heavily on a rise of the surtax yield. The Conference Board study also underestimates the potential yield of corporation taxes though a final answer depends on the results of controls on corporate income. Its estimate is that the maximum available draft on corporate income (prior to the 1941 Act) was $1.6 billion. The 1941 act has already increased the tax burden on corporations by $1.4 billion. Professor Hart estimates the corporate tax base in the period just ahead at $9 billion (exclusive of inter-corporate dividends). This figure may be low, but in any case, the tax assessment even now is but $4 billion. At higher income levels in 1942, the rise of corporation taxation may well yield several billion additional. In 1937, the distributable net income was $10.2 billion, cash dividends $7.3 billion and taxes $1.4 billion.

Again, a suggested limit of $\frac{3}{4}$ to $\frac{4}{5}$ for the excess profits tax seems too low. The American experience in the last war and current British experience with 100 per cent tax (and possible rebates of 20 per cent in the post-war period) give an indication of the possibilities. Business profits are today

largely determined by government demand. A satisfactory market is assured for the vast majority of market provisioners. A seller's market of this type calls for heavy excess profits. Adverse effects on motivation are not likely to be serious. The Conference Board study also underestimates the possibilities of taxes on luxuries. Our experience in the last war and the twenties is not conclusive on this score. Unsatisfactory yield will be explained by a factor not given adequate attention by the Conference report: curtailment of production. But the government has not adequately explored the possibility of supplementing scarcity with high prices inflated by severe taxes. This is the correct procedure for commodities on the luxury list.

Not satisfied with an elaboration of the fiscal aspects of the problem, the Conference Board also estimates the amount of real resources available for the defense effort. Unfortunately the real and financial aspects are not integrated well. Furthermore, the estimates of optional consumption and expenditures above practical minimum level raise serious questions of definitions. "As in the case of minimum expenditures, efficiency expenditures are increased as income increases on the basis of food expenditures"[1] (p. 25). Optional expenditures are the excess of total expenditures over efficiency expenditures, which are, as is indicated above, obtained in a very crude manner. Again, we are informed that optional consumption in 1937 for automobiles, for example, was 25.9 per cent of total expenditures. Obviously the optional ratio will be larger for short periods than for long periods. Expenditures for automobiles may well be cut by 75 per cent in the next few years. Another troublesome point is the interrelation for groups of items of the percentages of optional to total expenditures. Will consumption of each class of items be cut equally if the reductions are applied to all classes as if they were applied to but one or a few classes? Does a reduction of 26 per cent in automobile expenditures make more difficult or less difficult a reduction of x percentage in recreation?

In this brief review, the writer has noted several points of disagreement with the Conference report. He is not, however, unaware of the many points of agreement, the rich collections of materials made available by the resources of the Board, the excellent summaries of tax and debt history, and the interesting study of income, consumption, and sales. No student of our present fiscal problems can afford to do without this volume.

SEYMOUR E. HARRIS

Harvard University

Air Transportation, by Claude E. Puffer. Philadelphia: The Blakiston Company. 1941. xxiv, 675 pp. $3.75.

This book is primarily an economic description and history of the air transportation industry in the United States. It is well written and very

[1] "The ratio of total expenditures ($1316) to food expenditures at the efficiency level ($487) was 2.7. The efficiency level would then be $617 × 2.7 or $1666." (Food expenditures at this income are estimated at $617.)

comprehensive, and hence fulfills an urgent need of present students of the subject. The author applies the typical demand and cost analyses of economic theory to the services offered by the air carriers—passenger, mail, and express. The study includes a well-organized discussion of the legal characteristics of the industry, the functions of the Civil Aeronautics Board, intercorporate relationships, labor relations, and safety regulations.

Only one major criticism appears to the reviewer. The author chose to follow the lead of Paul T. David and Joseph B. Eastman in his analysis of the public aid included in air mail payments. This school of thought contends that such aid should be measured by the excess of Post Office disbursements to the airlines above the airlines' cost of rendering the required service. The trouble with this line of reasoning is that it leads to some peculiar conclusions. It could be concluded, for example, that one way to eliminate such public aid would be to increase the costs of the airlines to the extent that there would be no excess of disbursements over costs. It could also be concluded that the airlines' cost of rendering the required service could be increased by any amount named and there would be no increase in public aid if the Post Office disbursements were increased by a like amount. The reviewer holds that such aid is the excess of Post Office disbursements over net revenue from air mail.

The magnitude of public aid contained in the air mail payments of the past is really of little significance in the future of this industry, but the author used this same type of analysis in his discussion of rate-making, which is a question of primary importance.

He states that the basic consideration in determining mail payments "should be the cost [of performing mail service] incurred by the carriers (including a reasonable profit), irrespective of what the government receives in postal revenues." At this point the author parts company with Mr. Eastman who said of one of his own works, "this study is not intended to yield the type of cost analysis required for rate-making purposes." In the opinion of the reviewer, a sound rate-making policy for the airlines cannot ignore the air mail revenue of the Government.

Harold J. King

University of Pittsburgh

Air Mail Payment and the Government, by F. A. Spencer. Washington: The Brookings Institution. 1941. xii, 402 pp. $3.00.

This book is a clean-cut job. The author runs through the periods of air mail transportation without getting lost in detail, and yet with convincing thoroughness. An astonishing amount of information is presented about the air mail; in fact, about the air transportation business. There is a good balance between the review of policies under the several governmental bodies in control at one time or another and the criticism of the policies. Where the lapse of time permits, historical judgment of adequacy is used. This is aptly applied to the period of Interstate Commerce Commission rate making.

Controversies are analyzed with apparent fairness. The Post Office Department and the Interstate Commerce Commission difficulties in joint administration are well stated. Likewise, the slow progress of the Civil Aeronautics Authority and the Civil Aeronautics Board in determining sound over-all policies for air mail pay is criticized. At the same time, the author analyzes the problem and finds its complexities great. There is the "subsidy" question, sufficient in its implications for an accounting convention of outstanding interest. Differences between the criteria for public and private expenditures could be more fully analyzed than by the author. These have recently been well discussed by the National Resources Planning Board in its report on *The Economic Effects of the Federal Public Works Expenditures, 1933–38.*

Efforts to rationalize governmental aid by the profit criterion of business seem unlikely to lead to constructive policies. While the major criticisms of the author are appropriately directed at what seem to be governmental faults or deficiences, he does not become counsel for the air mail contractors. His examples of watered stock, bad financing, and high costs are clearcut and specific. Specious arguments by operating companies for charging the mail with excessive fractions of gross operating charges are refuted.

Perhaps the most informative section for the reader interested in current practice is the extended chapter "Air Mail Compensation under the Civil Aeronautics Act." The rate policy section of the Act and its possible interpretations are well stated. Not merely "need" for compensation must be considered, but "a policy which encourages managerial efficiency."

Finally, the rapid growth of patronage of airlines leads the author to conclude, "If the present upward trend . . . continues, the Civil Aeronautics Board will soon be faced with the problem of deciding whether rates of air mail compensation or passenger and express rates shall be reduced (and, if so, in what proportion) in order to check unreasonable profits accruing to the carriers."

BALDWIN M. WOODS

University of California

Statistical Activities of the American Nations, 1940. Edited under the Direction of the Temporary Organizing Committee of the Inter-American Statistical Institute, by Elizabeth Phelps. Washington: Inter-American Statistical Institute. 1941. xxxi, 842 pp. $2.00.

Not since Koren's well-remembered *History of Statistics,* which commemorated the seventy-fifth anniversary of the American Statistical Association, has there appeared a more useful *aperçu* of the statistical set-up in a number of countries than the present volume, described in the sub-title as "a compendium of the statistical services and activities in twenty-two nations of the Western Hemisphere, together with information containing statistical personnel in these nations." Originating like Koren's in a commemoration—this time the twenty-fifth session of the International Institute

of Statistics scheduled to be held in Washington, 1939 (deferred to 1940 to coincide with the Eighth American Scientific Congress), with which a partial celebration of the American Statistical Centenary was to have been conjoined—the outbreak of war transformed both occasion and auspices. In the event, the International Institute and American Statistical sessions were cancelled; in their stead a statistical section was added to the Scientific Congress for a purely inter-American program of statistical papers, with the idea also of exploring the possibilities of a permanent inter-American statistical organization of professional character. The latter has since taken form as the "Inter-American Statistical Institute." The original "arrangements committee" likewise continued its work on the compendium which is now completed. Thus the purpose of the volume, which was to promote a north-and-south acquaintanceship in the world of statistics as supplementary to the predominant east-and-west flow of the past, has not only been retained, but in effect sets seal upon an epochal movement in international organization and relationships.

The treatment of subject matter is purely descriptive. For each of the twenty-two countries (alphabetically arranged) an authentic article by a local author was secured (for the United States, 23 such "author's articles" were necessary). This is printed in the language of the country (English, Spanish or Portuguese). Preceding each is a "summary" in all three languages. The plan of both article and summary calls for a review of (1) educational facilities, (2) library facilities, (3) statistical societies or associations, (4) non-official or semi-official statistical agencies, and (5) the official statistical system, its organization, progress to date, publications, etc. Though there is a natural tendency in such writing to "put the best foot forward," and though the efficiency of a statistical system must be measured only by its statistical results, the usefulness of such a survey for purposes of reference, especially to official statisticians, need not be stressed.

A striking revelation is the extent to which the Latin American nations have enacted legislation especially in recent years looking to the central control of statistics. At least a dozen, including all the leading ones, have Central Statistical Bureaus. Departmental compilation and publication, however, remain paramount in most. Statistical coordination in fact demands an amount of spade work in advance that is apt to be underestimated. But the beginning lies in the legal frame-work, and in this the South Americans almost without exception are well equipped.

The Directory of Statistical Personnel which concludes the volume lists the leading statisticians of each country (other than the United States) after the manner of *Who's Who*, an admirable introduction to the broader acquaintanceship which is to be.

For the improvement of economic relations throughout the American continents a compendium of this kind was a prerequisite. When prior to World War I a Royal Commission was appointed to explore similar possibilities within the British Commonwealth of Nations its very first recom-

mendation looked to a Conference of Statisticians to review the incompleteness and inconsistencies in official statistics which lay as a stumbling block across the threshold. Conferences in due course took place in London in 1920 and in Ottawa in 1935 with results of first-class benefit. Implicit in the present volume is the development of the Inter-American Statistical Institute as a necessary preliminary and impetus to a similar rapprochement in this Hemisphere.

ROBERT H. COATS

Dominion Bureau of Statistics

Industrial Corporation Reports (76 individual reports for leading manufacturing industries, covering operations during 1938–1939.) Federal Trade Commission, Washington, D. C. 1941.

This set of 76 reports on selected manufacturing industries resulted from the Federal Trade Commission's project for the collection of annual financial data from a large number of corporations operating in some principal manfacturing industries in the United States.

In each report there are presented financial data for 1938 and 1939, comprising a balance sheet, income and expense statement, and an earned surplus statement; also ratios and percentages derived from the basic data. The principal facts in the exhibits of data are domestic and foreign sales; costs and expenses in detail; investment, profits, and rates of return; dividends paid and net income retained by the corporations; operating ratios; inventories; important financial ratios; and increases and decreases in principal assets and liabilities. The 1939 information was obtained from financial reports submitted to the Commission. The 1938 information was procured from annual reports of public record made by the corporations, or from balance sheets submitted to the Commission; the 1938 data are not complete in every instance. All data shown for the several corporations canvassed in each industry are combined in a manner which does not identify the reports from any individual corporation.

The designation of each industry canvassed was made to conform with the "Standard Industrial Classification" used by various departments of the Federal Government. This makes possible ready reference to other statistics released by government agencies, particularly those of the Bureau of the Census.

The reports are limited to a presentation of basic data in terms of the amount of money value with only simple analysis. The scope of the work did not permit the Federal Trade Commission to make detailed adjustments of the reports of the various corporations to make accounting treatment and procedure entirely comparable. The possible variations, however, are held to be unimportant. All data follow the classification of accounts as generally reported by the corporations. Reclassifications in some instances were made by the Commission for the purpose of applying uniform accounting princi-

ples, or where other differences in the accounting method would have affected the comparability of the combined statistics.

There are some discrepancies in comparability with Census data that are explained. The total amount of sales for the limited number of corporations which were canvassed in nine of the 76 selected manufacturing industries exceeded the total value of products for each respective industry as reported by the Bureau of the Census. The reason for this is that Federal Trade Commission data pertain to complete operations of corporations while Census data are by establishments, and occasionally the operations of some plants of a given corporation have undoubtedly been reported in different industry classifications. Such discrepancies occur whenever the corporation operates a number of plants manufacturing different products, and also whenever it operates plants in foreign areas. In the latter case, the Bureau of the Census does not receive reports from foreign establishments of domestic corporations. The same discrepancy probably appears to a lesser extent in many more of the industry reports. Some quantitative indication, or correction if possible, of the amount of foreign operations and of included operations pertaining to other industries than the one reported should improve the future industrial reports.

As far as can be learned from using the statistics, the reports seem to be very carefully prepared, for practically no inconsistencies in data were found between the various parts of the publications and their exhibits. One exception was found in the summary of exhibits for the food specialty manufacturing industry, where the total costs and expenses figure apparently did not include selling and advertising, administrative and general office, taxes, and research and development expenses.

The reports fill a need in supplying statistical data on the financial operations of important industries and should be valuable to economists, statisticians, businessmen, and others interested in the productive activity of industrial corporations and in their financial results. The Commission's claim that much of the information in the reports is not elsewhere available in the same detail is undoubtedly true, and such reliable information about operating conditions may serve as a guide for business management. The Federal Trade Commission plans to publish similar industrial reports annually.

Oscar L. Endler

National Resources Planning Board

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